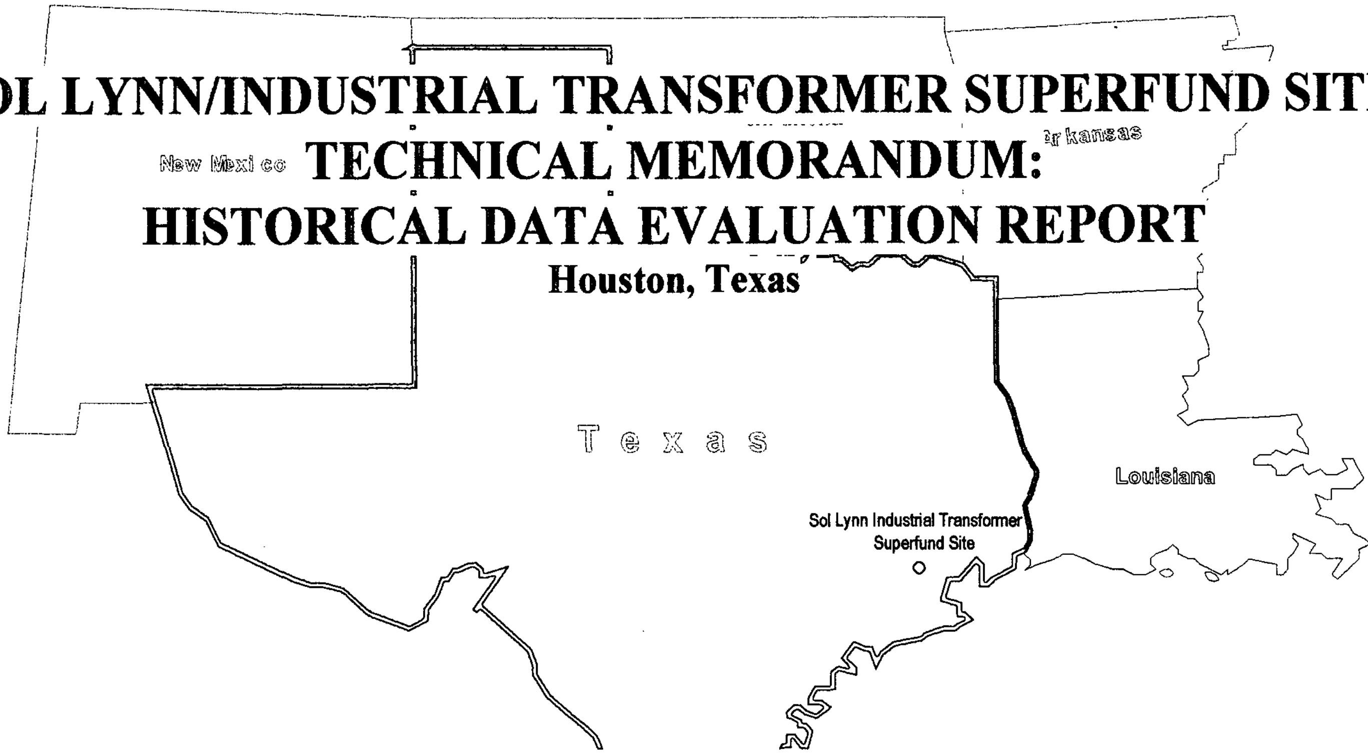
SOL LYNN/INDUSTRIAL TRANSFORMER SUPERFUND SITE
TECHNICAL MEMORANDUM: HISTORICAL DATA EVALUATION REPORT
Houston, Texas



Prepared for:
U.S. Environmental Protection Agency Region 6

March 2000

882951

Tetra Tech EM Inc.
350 N. St. Paul Street, Suite 2600
Dallas, Texas 75201
214.754.8765

Contract No.: 68-W6-0037
Work Assignment No.: 032-RI-CO-0680

TECHNICAL MEMORANDUM:
BACKGROUND DATA EVALUATION REPORT

FOR THE
SOL LYNN/INDUSTRIAL TRANSFORMER SUPERFUND SITE
HOUSTON, TEXAS
EPA ID NO. TXD980873327

Prepared for:

U.S. ENVIRONMENTAL PROTECTION AGENCY
1445 Ross Avenue
Dallas, TX 75202-2733

Contract No.	: 68-W6-0037
Work Assignment No.	: 032-RI-CO-0680
EPA Region	: 6
Date Prepared	: March 27, 2000
Prepared By	: Tetra Tech EM Inc.
Tetra Tech Project Manager	: Mr. Tim Startz
Telephone number	: (214) 740-2064
EPA Work Assignment Manager	: Mr. Ernest Franke
Telephone number	: (214) 665-8521

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

Page

TABLE OF CONTENTS (Continued)

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES (Continued)

APPENDICES

LIST OF ACRONYMS

APCA	Vapor phase carbon adsorption
bgs	Below ground surface
CETCO	Carbon distributor
CPT	Cone-penetrometer technology
DCE	Dichloroethene
DNAPL	Dense non-aqueous phase liquids
EPA	U.S. Environmental Protection Agency
ESD	Explanation of significant difference
EDR	Environmental Data Resources, Inc.
FS	Feasibility Study
g/m3	Grams per cubic meter
GAC	Granular activated carbon
gpd	Gallons per day
gpm	Gallons per minute
GWTP	Ground water treatment plant
ITS	Industrial Transformers Superfund
LQG	Large quantity generators
LUST	Leaking underground storage tank
MCL	Maximum contaminant level
mg/L	Milligrams per liter
MNA	Monitored natural attenuation
NPL	National Priorities List
NAPL	Non-aqueous phase liquids
O&M	Operation and maintenance
PCB	Polychlorinated biphenyl
PCE	Tetrachloroethene
ppmv	Parts per million by volume
QA/QC	Quality Assurance/Quality Control
RA	Remedial Action
RAC	Response action contract
Radian	Radian International Inc.
RCRA	Resource Conservation and Recovery Act
RCRIS	Resource Conservation and Recovery Information System
RI	Remedial Investigation
ROD	Record of Decision
SAP	Sampling and Analysis Plan
SQG	Small quantity generators
SWL	Southwestern Laboratories Environmental Service
TCE	Trichloroethene
TNRCC	Texas Natural Resources Conservation Commission
TSP	Total suspended particulates
TWC	Texas Water Commission
UV	Ultraviolet

LIST OF ACRONYMS (Continued)

µg/L	Micrograms per liter
VC	Vinyl chloride
VE	Vacuum extraction
VOC	Volatile organic compound
VPCA	Vapor phase carbon adsorption
WWTP	Wastewater treatment plant

1.0 INTRODUCTION

Tetra Tech EM Inc. (Tetra Tech) received Work Assignment 032-RI-CO-0680 from the U.S. Environmental Protection Agency (EPA) (Region 6) under Response Action Contract (RAC) 68-W6-0037. Under this Supplemental Remedial Investigation and Feasibility Study (RI/FS) work assignment, Tetra Tech was directed to provide a technical memorandum summarizing and evaluating the historical record for the Sol Lynn/Industrial Transformer Superfund (ITS) site located in Houston, Harris County, Texas (EPA 1999). The estimated completion date for this work assignment is March 30, 2001.

The remainder of this section provides a site description and background, a description of site-related contaminants, a summary of previous remedial measures, the purpose and objectives of the supplimental RI/FS, and the organization of the technical memorandum.

1.1 SITE DESCRIPTION AND BACKGROUND

This section provides a physical description of the site and a chronology of site-related activities and events.

1.1.1 Site Description

The site is located within the city limits of Houston, Texas, just south of Interstate Highway 610 (I-610) and west of State Highway 288 (Figure 1-1). The site is bounded on the north by South Loop Feeder Street of I-610, east by South David Street, south by Mansard Street, and west by Knight Street (Figure 1-2). Site features include two buildings and a loading area in the northern portion of the site. Much of the southern portion of the site is paved. The site is currently defined by permanent monitoring locations (Figure 1-3), encompasses about 0.75 acre.

Within 1 mile of the site are residential, commercial business, and light industrial areas. The commercial business and light industrial areas are located directly east and south of the site. Private, single, and multi-family dwellings are located about 3,000 feet west of the site, and the Astroworld and Astrodome sports facilities are located approximately 4,000 feet to the northwest.

The residential population within a 1-mile radius of the site is about 2,000. Maximum daily traffic of 100,000 persons is estimated to move within a 1-mile radius of the site, primarily due to major daily highway traffic on I-610 and recreational activities associated with the Astrodome and Astroworld (EPA 1999).

1.1.2 Site Background

A detailed chronology of site-related activities and events is listed in Table 1-1.

As early as 1965, the Industrial Transformer Company, which was owned and operated by Mr. Sol Lynn, was operating at 1415, 1417, and 1419 South Loop West. These properties form the site boundaries shown in Figure 1-2. Site operations included metals reclamation from scrap metal and electrical transformers. Monitoring locations installed to date and detailed site features are shown in Figure 1-3.

In fall 1971, City of Houston workers noted that employees at the site were pouring oil from the transformers directly onto the ground as they were dismantling the electrical transformers. As a result, Mr. Lynn was given a series of 7-day notices by the Texas Natural Resources Conservation Commission (TNRCC) (then the Texas Water Commission [TWC]) to confine oil and grease to his property. Subsequent inspections revealed that corrective actions had not been implemented at the site. On September 11, 1972, the State of Texas brought suit against Mr. Lynn on charges of illegally discharging industrial waste into Brays Bayou, a body of water located 1.6 miles from the site. Mr. Lynn was ordered to pay a $100 fine. A subsequent inspection in 1978 by TNRCC showed no signs of oil spills or unauthorized discharges.

In 1975, a portion of the ITS site was leased by Mr. Ken James, who operated a chemical supply company, Sila-King, on the property. Mr. James leased the portion of the ITS site from 1975 through 1981. On January 13, 1980, while Sila-King was conducting operations at the site, a TNRCC representative observed old drums and an oil discharge from the drum storage area behind 1419 South Loop West.

On September 11, 1981, samples collected by the City of Houston indicated that soil and ground water were contaminated with trichloroethene (TCE). On November 14, 1981, a City of Houston work crew noted strong chemical odors while installing a waterline adjacent to the site. An inspection later that day by representatives of both the TNRCC and the City of Houston Department of Health identified about 75 empty drums scattered about on the property. Most of the drums were labeled as TCE, were empty, and had puncture holes in them. By March 1982, the drums had disappeared from the ITS site.

On February 29, 1984, as a result of the above events, TNRCC requested that EPA rank the site for possible inclusion on the National Priorities List (NPL) and for possible corrective action through the Superfund program. On April 16, 1984, a Hazard Ranking System request was submitted to EPA Region 6 for the site to be included on the NPL, and it was subsequently listed on October 5, 1984. On June 30, 1986, TNRCC entered into a contract with Radian Corporation (Radian) to conduct an RI/FS at the Sol Lynn/ITS site. Field activities associated with the investigation began on January 14, 1987.

1.2 DESCRIPTION OF SITE-RELATED CONTAMINANTS

Site contaminants consist of chlorinated solvents (primarily TCE and related decay products) and polychlorinated biphenyls (PCB). Site soils are contaminated with TCE, possibly as pure phase product, and PCBs. Site ground water is contaminated with TCE in each of the three water-bearing zones at the site.

1.2.1 Chlorinated Hydrocarbons

Chlorinated hydrocarbons or solvents detected on the site consist primarily of TCE, 1,1-dichloroethene (DCE), and vinyl chloride.

Chlorinated solvents were first produced in Germany in the nineteenth century. Production in the U.S. began around 1906 with tetrachloroethene (PCE). Production of TCE and PCE began in 1923. Widespread use of chlorinated solvents in manufacturing began during World War II, and increased markedly during the next three decades. TCE and PCE became the most commonly used solvents in the 1960s, when the post-World War II manufacturing economy expanded greatly (Pankow 1996). Because chlorinated solvents are more dense than water, they are known as dense non-aqueous phase liquids (DNAPLs). If released into the environment in sufficient quantities, DNAPLs have the capacity to migrate into the saturated zone, potentially providing a long-term source of contamination to ground water (Pankow 1996).

1.2.2 Polychlorinated Biphenyls

PCBs were first formulated in 1881. However; manufacturing on a commercial scale did not start until 1929. The widespread use of PCBs was due to their nonflammable characteristics as well as their chemical inertness, heat resistance, chemical stability, low vapor pressure at atmospheric temperature, and high dielectric constant. PCBs were used as plasticizers in synthetic resins, hydraulic fluids, adhesives, lubricants, cutting oils, heat transformers, and in many other applications (Lavigne 1990). In the late 1960s, PCBs were recognized as a potential environmental problem. Until that time, maintenance and handling of PCB-containing equipment was unregulated. All U.S. production of PCBs was halted in 1977.

1.3 SUMMARY OF PREVIOUS REMEDIAL MEASURES

As promulgated in the March 25, 1988, Source Control Record of Decision (ROD), the remedy for cleanup of contaminated waste (source) materials at the site specified chemical dechlorination. While the dechlorination process reportedly performed well at the bench-scale, field-scale operations were ineffective in reducing contaminant levels as specified in the ROD (EPA 1988). As a result, the Source Control ROD was amended on September 20, 1992. The amended ROD specified source control measures, including the excavation and offsite disposal of contaminated soil. This remedial measure was conducted previously. Approximately 2,400 cubic yards of soil contaminated with PCBs and TCE was removed.

As specified in the September 23, 1988, Ground Water ROD, the remedy for ground water cleanup at the ITS site involved extracting contaminated ground water and treating it using air stripping (EPA 1988). The ground water extraction and treatment system is currently in operation at the site.

1.4 PURPOSE AND OBJECTIVES OF THE SUPPLIMENTAL RI/FS

The purpose of the supplemental RI/FS is to collect additional data necessary to support the detailed needs and selection of an approach for site remediation. The objective of this work assignment is to obtain additional data for the following uses:

- Evaluate and potentially amend the existing ROD (EPA 1988b) by modifying the Description of Selected Remedy or existing treatment facility as supported by an Explanation of Significant Difference (ESD).
- Select potential alternate approaches for ITS remediation within 16 months after approval of the project management and work plans (EPA 1999).

This Background Data Evaluation Technical Memorandum summarizes, evaluates, and interprets the existing site data and historical record and identifies additional data needed to satisfy the above objectives.

The need for the supplemental RI/FS is the result of (1) the inadequacy of the existing ground water extraction and treatment system to reduce contaminant concentration levels within the current scheduled contract time, and (2) the inability of currently available data to delineate the contaminant plume and migration pathways with respect to the site boundaries and potential receptors. Additional field investigation is necessary to gather information for the following purposes:

- Define the lateral and vertical extent of TCE and its degradation products, particularly DCE and vinyl chloride.
- Further define the site geologic conditions.
- Evaluate the hydrogeologic characteristics (hydraulic properties, horizontal and vertical hydraulic gradients, and interconnection) of the contaminated water-bearing zones.
- Assess the potential for remediation by natural attenuation in the multi-aquifer system using geochemical data and other indicators.
- Identify existing and potential receptors of contaminants migrating from the .
- Evaluate the effectiveness of the existing ground water extraction and treatment system, and recommend improvements to enhance the system (such as a different pumping and recharge schedule or additional extraction and injection wells).

- Identify and evaluate other appropriate and effective proven remedial alternatives.

The integration or modeling of the data summarized in the technical memorandum and the supplemental field data is designed to produce an efficient effort that is timely, cost-effective, and fit-for-purpose in obtaining the above objectives.

1.5 TECHNICAL MEMORANDUM ORGANIZATION

This technical memorandum summarizes, evaluates, and interprets available data and information previously collected at the site. Section 1.0 is an introduction and provides a general description of the site and background information, contaminants of concern, remedial efforts previously implemented at the site, purpose and objectives of the supplemental RI/FS, and organization of the technical memorandum. Section 2.0 summarizes previous investigations and evaluations conducted at the site. Section 3.0 presents existing information regarding the geological and hydrogeological setting of the site as well as an updated hydrogeological conceptual model of the site. Section 4.0 presents a summary of existing information regarding the distribution of contaminants and contaminant migration, and presents conceptual model components. Section 5.0 addresses potential remedial alternatives to be evaluated. Section 6.0 summarizes the data requirements and recommendations identified during the development of the technical memorandum. Section 7.0 lists the references.

2.0 SUMMARY OF PREVIOUS INVESTIGATIONS

This section provides a brief summary of past investigative and remedial activities performed at the site. Subsection 2.1 presents data from investigations performed before 1990. Section 2.2 summarizes data obtained during the 1990s. Section 2.3 provides information on ground water modeling studies conducted at the site. Section 2.4 presents an overview of the remedial activities. Section 2.5 provides a history of the ground water extraction and treatment system and includes a brief evaluation of the system's performance.

2.1 PRE-1990 REMEDIAL INVESTIGATION AND FEASIBILITY STUDY ACTIVITIES

In the early 1980s, regulatory agencies and the property owner collected a total of 101 soil samples and 25 water samples. Based on analyses conducted by these parties, TCE and PCBs were established as the primary contaminants of concern at the Sol Lynn/ITS site (Radian 1988a).

On May 27, 1986, TNRCC selected Radian Corporation as the consultant for RI/FS activities at the site. The contract was executed on June 30, 1986, and amended on October 28, 1987, to include additional investigative activities. Subsection 2.1.1 summarizes Phase I RI activities. Subsection 2.1.2 summarizes Phase II RI activities, which focused on TCE contamination in the ground water. Subsection 2.1.3 summarizes the FS for ground water contamination identified during the Phase II RI.

2.1.1 Phase I Remedial Investigation

The objective of the Phase I RI was to identify the lateral and vertical extent, concentration level, and volume of contaminants at the site. Radian assessed existing conditions at the site through the sampling and analysis of surface and subsurface soil, sediment, ground water, and surface water. Goals of the RI included: (1) characterization of site geology, including geotechnical testing of soil samples; (2) characterization of site hydrogeology, including measurement of static water levels in all monitoring wells and determining hydraulic gradients in the uppermost aquifer; (3) evaluating contaminant pathways and migration rates; (4) identifying target receptors and potential impacts, including inventorying all water wells within a 1-mile radius of the site; and (5) compiling sufficient data to evaluate potential remedial activities.

Radian collected 53 surface soil samples and 136 soil samples from shallow and deep boreholes, including 7 boreholes installed for monitoring wells. These soil samples were analyzed for one or more of the following contaminants: PCBs; volatile priority organic pollutants (VPOP), including TCE; and dioxin.

Based on the soil analyses, the area of PCB contamination was determined to be about 0.71 acre and was limited to the upper 2 feet of soil in the empty lots behind the addresses 1403, 1415, 1417, and 1419 South Loop 610 West and extending west of those lots about 80 feet. VPOP analyses of soil samples indicated minimal concentrations of several organic compounds. However, TCE was detected at concentrations as high as 2,000 milligrams per kilogram (mg/kg) in the uppermost aquifer sand. Dioxin was not detected in the soil samples analyzed.

The ground water assessment included (1) converting six soil borings completed in the uppermost water-bearing zone into monitoring wells and (2) completing one 99-foot-deep monitoring well in the lower intermediate water-bearing sand. Analyses performed on the uppermost and intermediate ground water samples included TCE and VPOP (Radian 1988a). Figure 1-3 shows the monitoring well locations.

Based on ground water sampling, the highest TCE concentration in ground water (500 milligrams per liter [mg/L]) was reported in MW-2. However, Radian reported that, based on a review of the ground water gradient and the observation of significant TCE concentrations in upgradient wells, the plume did not originate at MW-2. Radian identified several possible explanations for this, including (1) reversal of ground water gradient over time or (2) several scattered sources of TCE contamination at or near the surface that migrated vertically to the uppermost water-bearing zone.

In addition to providing information on the nature and extent of contamination, data gathered from the monitoring well installation provided other geologic and hydrogeologic information.

The Beaumont Formation of Pleistocene age directly underlies the site. The uppermost lithologic unit consists of clay, which extends from the surface to 30 to 35 feet below ground surface (bgs). A thin, 2- to 3-foot-thick layer of silty, sandy clay occurs within the uppermost clay at 18 to 21 feet bgs across the eastern portion of the site. The uppermost water-bearing sand (clayey sand with an average thickness of 5 feet) underlies the uppermost clay. Underlying the water-bearing sand is a 49- to 64-foot-thick stiff clay that was deposited above the intermediate water-bearing zone. The intermediate water-bearing zone, which occurs at 84 to 94 feet bgs, is a clayey sand.

A north to northwesterly ground water flow direction was identified in the uppermost water-bearing sand. The observed hydraulic gradients range from 0.0030 to 0.0036 foot per foot. The static water level averaged 3 to 4 feet bgs for the shallow wells. Hydraulic conductivity estimates for the uppermost water-bearing zone ranged from 0.63 to 2.03 feet per day.

The intermediate water-bearing zone is composed of 50 percent fine sand and 50 percent silts and clays. The static water level in intermediate wells averaged about 25 feet below the ground surface. The hydraulic conductivity for the intermediate zone was estimated at 0.029 feet per day.

During the Phase I RI, Radian also collected seven surface water samples and analyzed them for PCBs, two from ponded water on the site, three from ditches adjacent to the site, and two from ditches downstream of the site. One sample contained 0.0011 mg/L PCBs. VPOP analyses were conducted on two of the seven surface water samples, and TCE was detected at up to 0.0026 mg/L. No other organics were found in significant concentrations.

Six sediment samples were collected and analyzed for PCBs, four from ditches adjacent to the site and two from ditches downstream of the site. PCB concentrations ranged from 0.17 to 47 mg/kg. Because a background sediment sample was not collected, the presence of PCBs in the ditches could not be fully attributed to the site.

Finally, air samples were collected both upwind and downwind of the site. No PCBs were detected in the four air filters collected after the start of field sampling activities. Concentrations of total suspended particulates (TSP) ranged from 22 to 54 to 78 grams per cubic meter (g/m^3) upwind of the site, and from 43 to 45 to 123 g/m^3 downwind of the site. TSP concentrations accumulated in upwind and downwind filters did not provide conclusive evidence of significant contributions from the Sol Lynn/ITS site.

Radian concluded that areas containing PCB concentrations above 25 ppm and TCE concentrations above 161 ppm would require remediation (Radian 1988a). The TCE action level was based on risk analyses conducted by the Agency for Toxic Substances and Disease Registry (ATSDR). Using these action levels, Radian identified an area of contaminated soil measuring about 3,422 square yards to a depth of 2 feet, or a volume of 2,281 cubic yards.

Radian also indicated that ground water contamination at the site would be further investigated during the Phase II RI. The presence of TCE in all of the ground water samples from the uppermost water-bearing zone (in concentrations ranging from 0.0007 to 500 mg/L) and in the intermediate water-bearing zone (in concentrations ranging from 0.12 to 26 mg/L) provided justification for the additional investigation. The drinking water ingestion pathway, which may be impacted by TCE contamination, was to be addressed in more detail upon completion of the Phase II RI.

2.1.2 Phase II Remedial Investigation

The objective of the Phase II RI was to define the nature and extent of TCE contamination in the uppermost and intermediate water-bearing units. To meet this objective, Radian (1) reviewed results of previous investigative activities and identified data gaps and insufficiencies, (2) proposed responses and remedial technologies to clean up TCE-contaminated soil and ground water in the uppermost and intermediate water-bearing zones, and (3) conducted field investigative activities. These activities included the installation of three monitoring wells in the intermediate water-bearing zone. During borehole installation, soil samples were collected from the 0- to 2-foot interval within each borehole and analyzed for PCBs. Another 52 discrete locations within the monitoring well boreholes were sampled for potential TCE analysis; 30 of these samples were analyzed for TCE, based on headspace field screening results. A total of 15 ground water samples were collected from six existing shallow wells and the three newly installed intermediate wells during two separate monitoring rounds; these samples were analyzed for TCE. Finally, cone penetrometer technology (CPT) soundings were made and water samples were collected from 20 locations on and near the site.

Based on the field work, the highest ground water TCE concentration (790 mg/L) was identified at CPT C-13 (north-northwest of the site in the median strip between the ITS site and South Loop 610 West).

Water level measurements collected from the upper-most water-bearing zone, at depths of about 33 feet bgs, defined the site potentiometric surface and the direction and hydraulic gradient of ground water flow. A north-northwesterly flow was observed in the uppermost water-bearing zone, with gradients ranging from 0.0031 to 0.0039 foot per foot. Static water levels in monitoring wells completed in the uppermost water-bearing zone averaged 39 to 41 feet above mean sea level. Hydraulic conductivity data for the uppermost water-bearing unit ranged from approximately 0.63 to 2.0 feet per day.

Water level measurements collected from the intermediate water-bearing zone defined a southeasterly ground water flow, with static water levels averaging about 20 to 22 feet above mean sea level. Hydraulic conductivity data for the intermediate water-bearing zone ranged from 0.31 to 0.87 feet per day. Thickness of this unit ranged from 5 to 6.5 feet.

Based on the Phase I and II investigations, Radian noted that a TCE plume exceeding 0.005 mg/L exists in the uppermost water-bearing zone and is migrating in the direction of ground water flow to the northwest. TCE was also identified in upgradient locations. Radian offered possible explanations, including a reversal of the hydraulic gradient over time and isolated near surface sources of TCE that may have migrated down to the uppermost water-bearing zone. TCE may have migrated vertically down through the clay until reaching a more permeable silty clay lens, then moving laterally along these lenses as well as continuing to migrate vertically.

Radian concluded that the extent of the TCE plume in the intermediate water-bearing unit could not be determined based on the information gathered during Phase II activities.

2.1.3 Phase II Feasibility Study

Following on to the Phase II RI, Radian conducted a FS. Site conditions and cleanup limits were the major factors considered in reviewing potentially applicable technologies to remediate ground water and subsurface soil, and the study focused on those actions that would be potentially effective in remediating site ground water to the TCE cleanup criteria of 0.005 mg/L.

After identifying potentially applicable technologies, Radian conducted a screening analysis consistent with the CERCLA process. Preliminary technical evaluations of 14 initially identified alternatives eliminated eight alternatives from further consideration, resulting in the selection of six remedial alternatives for detailed analyses. Two of these alternatives, the soil and ground water No Action alternatives, were combined, leaving the following five alternatives for the detailed analysis (Radian 1988c):

- **No Action.** No remedial activities other than monitoring would occur at the site.
- **Ground Water Collection and Off-site Disposal.** Contaminated ground water would be collected, transported off site to a deep well injection facility, and injected into deep, isolated, impermeable, geologic strata.
- **Ground Water Collection and On-site Physical Treatment.** Contaminated ground water would be collected, treated on site using carbon adsorption processes, and discharged.
- **Ground Water Collection and On-Site Chemical Treatment.** Contaminated ground water would be collected, chemically treated using catalytic dehydrochlorination processes to remove chlorine and hydrogen molecules, and discharged.
- **Ground Water Collection, On-site Physical Treatment, and Offgas Treatment.** Contaminated ground water would be collected, treated on site using an air stripping system, and discharged; TCE in the offgas would be treated in a carbon column before being discharged.

The latter was the selected remedial alternative. Specific design characteristics for this remedial alternative are discussed in Section 5.0.

2.2 EARLY 1990s CONTINUOUS DATA EVALUATION

The following subsections provide an overview of the major investigative activities performed at the site in the early 1990s, including an investigation of the shallow, silty, water-bearing zone (Silty Zone) (Subsection 2.2.1) and baseline ground water sampling (Section 2.2.2).

2.2.1 Silty Zone Investigation

In 1992, Radian conducted a field investigation of the Silty Zone, which is about 20 feet bgs. The main objective of the investigation was to determine design parameters required to develop an effective remedial program for the Silty Zone. Specific objectives included identifying suspected and known contaminants and potential sources and pathways of contamination, defining the nature and extent of contamination, and defining hydrogeological characteristics of the Silty Zone.

During the Silty Zone investigation, Radian conducted the following activities (Radian 1993):

- Conducted CPT soundings at 15 locations (CPTs C32 to C46) to depths of about 25 feet bgs and collected 14 ground water samples at these CPT locations.
- Installed and developed four monitoring wells (MW-23 to MW-26) in the Silty Zone to depths of about 25 feet bgs.
- Sampled the four new Silty Zone wells and the First Gibralter Bank well (FGB-1), which is also completed across the Silty Zone.
- Conducted a ground water pumping and recovery test to determine the hydraulic properties of the Silty Zone. One of the newly installed Silty Zone wells was pumped, and ground water drawdown was observed at 8 monitoring wells installed in the Silty Zone (Shallow Aquifer as redefined in current data evaluation report), Shallow Aquifer Zone (Intermediate Aquifer), and Intermediate Zone (Deep Aquifer).

As a result of the investigation, the primary permeable zones identified near the ground surface included the 20-foot silty sand zone (Silty Zone) and a 35-foot shallow sand zone. A discontinuous silty zone was found at about 35 feet bgs. The Silty Zone has an estimated hydraulic conductivity of 1.34×10^{-3} centimeters per second (cm/sec), and the 35-foot shallow sand zone was more permeable, with an estimated hydraulic conductivity of 9.01×10^{-3} cm/sec.

With respect to the TCE contamination at the site, elevated concentrations of dissolved TCE in the Silty Zone generally correlated to areas with high soil concentrations of TCE during the Phase I RI. Within Silty Zone ground water, dissolved TCE concentrations exceeded 1,000 mg/L in the center of the plume, suggesting that residual pure-phase TCE product (DNAPL) may exist within the soil and aquifer. High dissolved concentrations were deemed potentially attributable to the slow release of residual TCE. The dissolved TCE plume extends from Mansard Street in the south to just north of the southern greenbelt of I-610. In addition to TCE, vinyl chloride and several other TCE degradation products were detected in Silty Zone ground water.

Radian presented the following recommendations regarding future work at the Sol Lynn/ITS site:

- Install monitoring wells and collect soil and ground water samples from the monitoring well borings east and north of the Sol Lynn/ITS property, including one screened in each unit of concern (Silty Zone, Shallow Sand, and Intermediate Sand).

- Conduct an investigation to determine whether or not DNAPLs are present.
- Periodically survey ground water drawdown and extraction well vault elevations to monitor for ground surface subsidence.

2.2.2 Baseline Ground Water Sampling Investigation

In 1993, Southwestern Laboratories Environmental Services (SWL) conducted baseline ground water sampling activities. The sampling event was conducted after the first installation phase of extraction, recharge, and monitoring wells was conducted, but before operation of the remedial system. The sampling results represent initial ground water flow conditions and contaminant levels for the remedial system.

SWL gauged, surveyed, and sampled a total of 50 extraction, recharge, and monitoring wells during the event. Static water level measurements and potentiometric surface elevations were determined for each of the three water-bearing zones, and ground water samples were analyzed for TCE.

Based on the chemical analysis, TCE concentrations in the Silty Zone (uppermost water-bearing zone) monitoring wells ranged from 26 to 650 mg/L. In the silty zone extraction and recharge wells, TCE concentrations ranged from 0.01 to 740 mg/L.

In the intermediate water-bearing zone monitoring wells, TCE concentrations ranged from less than 0.005 to 280 mg/L. In the extraction and recharge wells, TCE concentrations ranged from less than 0.001 to 630 mg/L.

In the deep water-bearing zone monitoring wells, TCE concentrations ranged from 0.071 to 26 mg/L. In the single extraction well within this zone, the TCE concentration was 19 mg/L.

2.3 GROUND WATER MODELING STUDIES

Radian conducted several ground water modeling studies at the Sol Lynn/ITS site to assist in the design, evaluation, and subsequent modifications of the extraction and treatment system. In 1991, prior to developing detailed specifications of the extraction and treatment system, Radian used the U.S. Geological Survey (USGS) Method of Characteristics (MOC) model to aid in the extraction system design.

In 1994, after 2 years of extraction and treatment system operation, Radian used MODFLOW to simulate ground water flow in the Silty Zone, and the modeling results were used to modify the remedial design and extend the remediation system to the Silty Zone (Radian 1994). In 1996, Radian conducted another ground water modeling study, using GFLOW, an analytical element model, to aid in evaluating the performance of the existing system (Radian 1996). The major modeling results and conclusions of 1991 MOC, 1994 MODFLOW, and 1996 GFLOW modeling studies are summarized in the following subsections.

2.3.1 MOC Modeling Report (1991)

Radian used the USGS two-dimensional MOC solute transport model to simulate TCE contaminant plume concentration, movement, and reaction to pumping over time. The MOC model solves the ground water flow and solute transport equations. A particle-tracking procedure is used to represent convective transport, and a two-step explicit procedure is used to solve a finite difference equation describing the effects of hydrodynamic dispersion, fluid sources and sinks, and divergence of velocity. Both transient and steady-state simulations are possible.

The objectives of the modeling were to (1) review a number of remediation schemes to optimize the number and location of ground water extraction and injection system wells, (2) estimate the time required to remediate ground water in the contaminated aquifer using the various proposed remediation schemes, and (3) estimate the volume of ground water produced by the recovery system to assist in designing a ground water treatment system.

The general approach taken to model the site consisted of the following steps:

- Calibrate shallow aquifer hydrodynamic characteristics to a 36-hour pumping test.
- Calibrate shallow aquifer TCE contaminant plume behavior from 1988 to 1991 using monitoring well sampling data from both of those years.

- Simulate pumping of the shallow aquifer for various periods with different well configurations to estimate the time required to remove TCE contamination from the ground water.

- Repeat the above processes for the intermediate aquifer.

Based on the modeling results, Radian recommended that a configuration of seven extraction wells and three injection wells be used to address shallow aquifer contamination. For the perched silty zone, one or more wells were recommended to be used concurrently with shallow zone remediation (further testing was recommended to determine required pumping rates and number of wells). Finally, Radian recommended the use of one extraction well to remediate the intermediate aquifer concurrently with the shallow zone remediation.

2.3.2 MODFLOW Modeling Report (1994)

Using MODFLOW, Radian conducted a 1994 modeling study to simulate ground water flow in the Silty Zone (Radian 1994). The objective of the modeling study was to expand the existing extraction and treatment system to include remediation of the Silty Zone. Modeling results were used to determine the most appropriate placement of pumping and injection wells, and to determine the amount of additional pumping required for remediation. Major modeling configurations and procedures include:

- A three-layer, quasi three-dimensional modeling approach was used. Layer 1 represented clay from the ground surface to approximately 15 feet bgs, Layer 2 represented the Silty Zone (approximately 20 to 22 feet bgs), and Layer 3 represented the Upper Sand Zone (approximately 30 to 40 feet bgs).

- The total area modeled was 4,380 by 4,380 feet. The model grid size varied from 10 by 10 feet in the more intensive data area to 675 by 675 feet at the model edges.

- The east and west boundaries of the model were oriented parallel to the natural ground water flow direction, and set as no-flow boundaries. The north and south boundaries were assumed to be constant head boundaries.

- Model parameters were initially based on literature and field determined values. Parameter values were adjusted during model calibration. The model was calibrated against observed ground water data during two pumping tests conducted in the 20-foot (Silty zone) and 40-foot zone (Upper Sand zone), respectively. Each model layer was assumed to be homogeneous and isotropic for both initial and calibrated parameters, but the parameter values between different layers were different.

- Sensitivity analysis was conducted to identify the parameter with the most impact on modeling results. Results of the sensitivity analysis indicate that the model is highly sensitive to variations in horizontal transmissivity in Layer 3.

- The MODFLOW model was used to compare several different remedial system configurations. The configuration was selected that would maximize the volume of extracted ground water.

Based on the modeling, the final proposed remedial system configuration consisted of 12 extraction wells in the Silty Zone and 13 extraction wells in the Upper Sand Zone. Based on the modeling, Radian recommended that 10 extraction wells would pump exclusively from the Silty Zone during the first 4 months of operations. During the fifth month, five extraction wells would pump from the Silty Zone, and six wells would begin pumping from the Upper Sand Zone. Meanwhile, seven injection wells would begin operating in the Silty Zone and the Upper Sand Zone. The total flow volume for the remedial system in the Silty Zone and the Upper Sand Zone was expected to be between 60,000 and 150,000 gallons per month during the first four months, and between 500,000 and 1,200,000 gallons per month thereafter.

2.3.3 Annual Modeling Evaluation (Radian 1996)

In March 1996, Radian submitted a modeling report to evaluate performance of the extraction and treatment system during operations from November 1994 to November 1995 (Radian 1996). The focus of the modeling effort was the ground water flow pattern in the Upper Sand Zone.

Radian used GFLOW, an analytical element model, to simulate site-specific hydrogeological conditions. Modeling assumptions and procedures are summarized as follows:

- The Silty Zone was modeled as a 6-foot-thick horizontal layer.

- The Upper Sand Zone was assumed to be homogeneous and isotropic. Aquifer hydraulic parameters were assumed to be the same as previously used for MODFLOW.

- Extraction wells were modeled in two ways. First, they were modeled in a transient simulation using the Theis equation to simulate ground water elevations in November 1995 and February 1996. Second, they were modeled as constant discharge, steady-state wells to estimate long-term, steady-state ground water flow pattern. Recharge wells were modeled as constant head steady state wells in both cases.

- The model was calibrated using ground water elevations observed in March 1991. Ground water head values at the modeling boundaries were adjusted to minimize the difference between the modeling results and the observed ground water elevations. Aquifer hydraulic parameters were not changed during model calibration.

- The model was first used to simulate transient ground water flow between November 1995 and February 1996. The model was then used to simulate long-term steady state ground water flow under two scenarios. The first scenario was based on current extraction and injection well configuration, and the second assumed that all the Upper Sand Zone injection wells were shut down.

Based on the modeling results, Radian noted that by November 1995, ground water flow at the site approximated the long-term, steady-state ground water elevations predicted by the model. However, the arrangement of extraction and recharge wells for the Upper Sand Zone did not contain the contaminant plume as it had been delineated. The modeling determined that a large volume of ground water was bypassing the capture zone and migrating north-northwest of the site. However, reducing the volume of reinjected ground water in the Upper Sand Zone was expected to improve capture from the area north of the Sol Lynn/ITS site.

2.4 REMEDIAL ACTIVITIES

The following subsections discus the ground water ROD, the remedial design and subsequent modifications, and the undertaken remedial action.

2.4.1 Record of Decision

Ground water remedial design at the Sol Lynn/ITS site began after September 1988, when EPA issued the ground water ROD (EPA 1988b). The ROD stated that the ground water remediation objective at the site was to reduce TCE concentrations in ground water to the drinking water standard of 0.005 mg/L within a 10-year period. The ROD specified extraction and treatment as the appropriate remedial alternative for about 12 million gallons of ground water exceeding the primary drinking water standard, with treatment being accomplished by air stripping followed by liquid-phase carbon adsorption. If offgas from the treatment system did not meet Texas Air Quality Criteria, it was to be treated using a carbon filtration unit. Treated ground water was to be discharged to a sanitary sewer or pumped back into the water bearing zone.

The ROD addressed ground water remediation of the Silty Zone and Upper Sand Zone. Dissolved TCE encountered in the Silty Zone in 1990 was to be addressed in the Remedial Action phase (Groundwater Technology 1990).

2.4.2 Remedial Design and Subsequent Modification

Radian developed the Remedial Design for the shallow and intermediate sands (Radian 1988). Before developing detailed design specifications, an investigation was conducted to supplement the RI data, and ground water modeling was conducted to assist in design of the ground water extraction system (Radian 1991a; Radian 1991b). Upon completion of the field investigation and the modeling simulations, detailed design and performance specifications were developed for the Silty Zone and the Upper Sand Zone remedial system (Radian 1992).

Based on the Silty Zone investigation results (Section 2.2.1), the Remedial Design was modified to address contamination detected in the Silty Zone. Modifications were specified based on MODFLOW simulations (Radian 1994) (Section 2.3.2). The modifications included adding extraction wells in the Silty Zone and recharge wells in both the Silty Zone and the Shallow Sand Zone. The modeling report also included a plan to adjust operation of the extraction and recharge wells to achieve the best remedial results.

2.4.3 Remedial Action (Ground Water Treatment Phase)

On October 8, 1993, Phase I of the ground water treatment operation began. This first phase included ground water extraction from the 10 Silty Zone extraction wells and the Upper Sand Zone extraction well. No recharge wells were in operation during Phase I operations (Radian 1996).

On October 12, 1994, Radian authorized Phase II of the Treatment Phase. After converting several Silty Zone extraction wells to recharge wells, Phase II involved the following operational components (Radian 1996).

- Ground water extraction from Upper Sand Zone extraction wells SE-1 through SE-6

- Ground water extraction from Silty Zone extraction wells SZE-1 through SZE-5
- Ground water extraction from Intermediate Sand Zone extraction well IE-1 (80-foot)
- Injection of treated ground water using Silty Zone recharge wells SZER-1 through SZER-5, SZR-1, and SZR-2, and Upper Sand Zone wells SR-1 through SR-7
- Surface discharge of any treated water not recharged into the aquifer

The extraction and treatment system was shut down between October 14, 1996, to December 22, 1998. The system was restarted on December 22, 1998, and current operations include the following (Radian 2000):

- Ground water extraction from 20-foot zone extraction wells SZE-1 through SZE-9 and SZER-1 through SZER-5
- Ground water extraction from 40-foot zone extraction wells SE-1 through SE-5
- No recharge wells are operating
- No operations in the 80-foot zone

2.5 GROUND WATER EXTRACTION AND TREATMENT DATA AND PERFORMANCE EVALUATION

Ground water extraction and treatment system status reports were submitted monthly and annually during operation of the system. This section summarizes several of the annual reports.

2.5.1 Remedial Action Oversight Contract November 1995 Status Report (Radian 1996)

This report included the monthly status report for activities conducted at the site during November 1995 and the annual project status for 1995. The report summarized work performed, monitoring and sampling results, treatment plant performance, and financial status to date. Major activities and findings are summarized as follows:

- The November 1995 ground water throughput was 450,134 gallons, of which 20 percent was recharged to the subsurface and 80 percent was discharged to storm drainage. TCE concentrations of the treated ground water during four sampling events were less than the MCL for TCE (0.005 mg/L).

- The actual volume of water treated was significantly less than the required monthly minimum specified in Radian's (1992) Final Design. The difference is attributed to lower than expected yields in the extraction wells. Possible explanations offered for reductions in yield were dewatering of the aquifer and plugging of the well screens.

- The air stripping emission rate and TCE concentrations in air were measured weekly. The monthly TCE emission rate was found to exceed the maximum allowable emission rate of 0.4 pounds of TCE per hour, so a primary and vapor phase carbon changeout was completed in November 1995.

- The annual sampling event was conducted in November 1995. The annual sampling included ground water elevation measurements and ground water TCE concentration analyses for all extraction, recharge, and monitoring wells. Maxim site personnel conducted the sampling. Radian provided oversight and collected split samples.

- Using data from the beginning of the Treatment Phase (September 1993) through November 1995, TCE concentrations decreased slightly in most of the Silty Zone wells. The sharp decrease in TCE concentrations observed in some wells may correlate to lowering the pump switch sensors during April 1995. Lowering the sensors increased ground water drawdown in the Silty Zone extraction wells, potentially pulling in ground water at lower TCE concentrations from the Upper Sand Zone.

Major recommendations in the report were as follows:

- Conduct a FS to determine if alternative remedial technologies methods may be better suited to remediate the site.

- Specifically, evaluate the use of soil vapor extraction technology and horizontal drain technology at the site.

- Reduce pumping rates in Silty Zone extraction wells for 1 month to determine if an increase in water levels in the Silty Zone will increase TCE concentrations.

- Evaluate the reduction of the velocity of the stripped vapor through the carbon adsorption unit to increase the utilization of carbon at the site.

- Evaluate the impacts of converting recharge wells SZE-2, SZE-4, and SZE-5 to extraction wells.

2.5.2 Remedial Action Oversight Contract Status Report (Radian 1997)

The report summarized activities conducted at the site during November 1996 and the annual review of the project status for 1996. The report summarized work performed, monitoring and sampling results, treatment plant performance, and project financial status to date. Site activities were summarized as follows:

- Based on field logs, the treatment system was not operational during November 1996. The system was shut down on October 14, 1996, after a leak in the underground conveyance piping was discovered.
- On November 18 through 22, 1996, MAXIM Technologies Inc. (MAXIM) performed the 1996 annual sampling event. Static synoptic water levels were recorded in all monitoring, extraction, and recharge wells at the site and ground water samples were collected.

Conclusions in the report were as follows:

- Using the data from the beginning of the ground water treatment phase through November 1996, TCE concentrations have decreased slightly at most extraction wells.
- MAXIM shut down all extraction wells on May 13, 1996, and Radian monitored the effects. Reduction in injection volume at recharge wells had a positive effect on capture of the plume downgradient of the site where extraction wells were in continuous operation. However, a portion of the plume appeared to move beyond the influence of the pumping system.
- Most monitoring wells in the Silty Zone showed decreases in TCE concentration. However, the trend of TCE concentration in the Silty Zone at the edge of the plume, especially in the vicinity of MW-24, was not consistent with long-term remediation under the current approach.
- TCE concentrations in the Upper Sand Zone monitoring wells did not have the same trend. In general, the TCE plume appeared to be migrating slowly to the northwest. The capture zone did not extend far enough to the north from the site. Potential DNAPL north of MW-2 was suggested as a continuing source.

The 1996 status evaluation report substantiated recommendations proposed in the 1995 status report. Additional recommendations included:

- Conversion of recharge well SZER-1 to an extraction well.
- Evaluation of ground water use, control, and contaminant transport in the area north of the site.

2.5.3 Ground Water Extraction and Treatment Performance Evaluation (MAXIM 1996)

In May 1995, MAXIM acquired the U.S. operations of Huntington Engineering and Environmental/Southwestern Laboratories, including ground water extraction and treatment system operations at the Sol Lynn/ITS site. MAXIM conducted a performance evaluation on the ground water extraction/injection and treatment systems at the site. Major conclusions of the evaluation are summarized as follows:

- High-low level sensors set in Upper Sand Zone extraction wells were causing excessive pump cycling, which limited well yields and development of the capture zone. Ground water production rates were determined to be approximately one quarter of the predicted rates.
- Ground water injection in the Silty and Upper Sand Zones coupled with pumping inefficiencies were likely promoting TCE plume dispersion and migration.
- Dissolved phase TCE concentrations in the Silty and Upper Sand Zones suggested the presence of DNAPLs.
- Comparison of the 1992 TCE plume with the 1995 plume showed no decrease of TCE concentrations in either the Silty Zone or the Upper Sand Zone.
- TCE discharge limits from the aqueous phase carbon adsorption (APCA) units were being achieved under current operating conditions. However, DCE discharge limitations had not been addressed to date. Negative DCE removal efficiencies exhibited in the primary APCA unit were likely caused by partial replacement of previously adsorbed DCE by TCE on the adsorption sites.
- Absence of documented TCE/DCE excursion in the APCA system discharge indicated that some quantity of the adsorptive capacity of the system remained undepleted at the current defined breakthrough point of 0.005 mg/L TCE.
- The primary APCA unit appeared to be achieving 25 to 50 percent of theoretical TCE and DCE adsorption capacities. Low VOC carbon capacities are most likely caused by use of the current breakthrough criteria.

- Negative DCE removal efficiencies exhibited by the primary vapor phase carbon adsorption (VPCA) unit were likely caused by partial replacement of previously adsorbed DCE by TCE on adsorption sites. It was also possible that DCE was being formed in the primary VPCA as a result of thermal degradation of TCE.

- Applicable TCE and DCE discharge limits from the VPCA units were being achieved under the current operating conditions.

- Absence of documented TCE excursions in the VPCA system discharge indicated that some quantity of the adsorptive capacity of the system remained undepleted at the current defined breakthrough point of 60 ppmv VOCs measured between VPCA units, or 30 ppmv VOCs measured at the stack.

- Failure of the iron filtration system to effectively control iron concentrations to less than 0.5 mg/L could reduce VOC adsorption capacity in the VPCA units.

Based on these conclusions, MAXIM suggested a number of recommendations, which are summarized as follows:

- Manual adjustments should be made to the in-line ball valves to maintain the maximum consistent drawdown. Continuous adjustments will be necessary until approximate steady-state conditions are achieved.

- Conduct pumping tests at the extraction wells to determine the optimum extraction configurations.

- Discontinue ground water reinjection until extraction well performance and optimum pumping configurations and rates can be quantified.

- Based on the suspicion that DNAPL exists at the site, the goal of the remedial action should be redefined from clean-up of TCE-impacted ground water to 0.005 mg/L over a 10-year period to long term hydraulic containment of TCE impacted ground water.

MAXIM also suggested specific recommendations for improving operations and monitoring the treatment systems.

2.5.4 Remedial Action Oversight Contract December 1999 Status Report (Radian 2000)

The 1999 status report (Radian 2000) was submitted after EPA issued the statement of work for a supplemental RI/FS in December 1999 (EPA 1999). The report provided a summary of the extraction and treatment system performance since the start of the system in September 1993, and the current status of the system. Major events not found in previous reports were summarized as follows:

- Ground water samples were collected from monitoring wells and extraction wells between September 1993 and 1999. TCE data were collected over the entire sampling period. DCE analysis was added in November 1998.

- Based on the time series charts, the extraction and treatment was shut down from October 1996 to December 1998, when operation of the system was resumed.

Radian performed an evaluation of the effectiveness of the existing recovery system using three methods as follows:

- Analysis of semi-logarithmic plots of TCE concentrations versus time to estimate additional time needed to achieve the specific cleanup level

- Comparison of the initial (prior to recovery system operation) TCE concentration to the current concentrations and estimation of the percent reduction.

- Evaluation of whether the TCE and DCE plumes are within the capture zone of the recovery system.

Major findings in the report are summarized as follows:

- The semi-logarithmic plots of TCE concentration versus time indicated that the long-term remediation goal would not be achieved with the existing extraction and treatment system.

- In comparison with initial concentrations, current TCE concentrations decreased in most of the monitoring, extraction, and recharge wells during operation of the recovery system. However, concentrations also increased in some wells, including several recharge wells. When the recovery system was shut down, increasing concentrations were generally noted.

- Neither the capture zone nor the plume could be accurately defined due to lack of monitoring wells screened at appropriate depths.

- The existing ground water treatment system was determined to be successfully removing TCE, DCE, and related degradation products from site ground water. The average TCE concentration after treatment in the air stripper and the primary carbon bed was approximately 0.00015 mg/L. The average TCE concentration after treatment in the final carbon bed was below detection limits.

Based on the results, Radian proposed several recommendations, as follows:

- Additional site monitoring should be performed. Radian proposed that quarterly reports be prepared.
- Additional monitoring wells should be installed to address different water bearing zones. A total of six monitoring wells were proposed.
- Convert monitoring well DS-3 (screened at a depth of approximately 60 feet) into an extraction well.
- Install an additional recovery well in the 60-foot zone.
- Based on monitoring results, determine additional extraction well locations in the Silty Zone and Upper Sand Zone.
- Reduce the extraction rate at the 80-foot zone extraction well IE-1.
- Conduct an additional investigation in the 60-foot zone to define the horizontal extent of contamination in this zone.
- Evaluate the need for a natural gas-fired thermal oxidation system based on capital and O&M costs.

3.0 SITE HYDROGEOLOGICAL CONCEPTUAL MODEL

The site hydrogeological conceptual model is essential for evaluating contaminant fate and transport, for designing effective ground water remediation systems, and for evaluating the performance of those systems. The conceptual model considers site physiography, topography, and meteorology; regional and site geologic conditions; regional hydrogeology; site hydrogeology; ground water flow; aquifer hydraulic characteristics; boundary conditions and interrelationships of the aquifer zones; ground water geochemistry; and ground water use in the vicinity of the site (Sections 3.1 through 3.9). Section 3.10 summarizes the hydrogeological conceptual model for the Sol Lynn/ITS site. Section 3.11 identifies data gaps that need to be filled during the supplimental RI/FS investigation.

3.1 SITE PHYSIOGRAPHY, TOPOGRAPHY, AND METEOROLOGY

The site physiography, topography and meteorology are discussed in this section.

3.1.1 Physiography

The Sol Lynn/ITS site is located within the city limits of Houston, Texas, in south-central Harris County. Southern Harris County is situated within the Texas Coastal Zone, a depositional plain with a gentle slope of approximately 1 foot per mile to the south-southeast, in the direction of the coast. The Texas Coastal Zone consists of the coast of the Gulf of Mexico in Texas and associated lands extending to about 50 miles inland. The Texas Coastal Zone is composed of low coastal prairies, salt marshes, lagoons, and coastline. Unconsolidated materials underlying the Texas Coastal Zone compose up the Texas coastal plain, a wedge of clastic and non-clastic sediment that thickens seaward and was deposited since the Eocene epoch. Rivers, streams, bayous, and meander belts have influenced topographic relief most recently. Larger streams that crisscross the area, such as the Trinity and the San Jacinto Rivers, have broad, shallow, incised valleys that are remnants of past erosional cycles (Fisher and others 1972).

In the Houston area, the Texas Coastal Zone is composed of several types of active depositional environments, including fluvial and deltaic systems, marine-barrier-strandplain-chenier systems, bay-estuary-lagoon systems, and eolian (wind-deposited) systems. The sediment that composes the Texas coastal plain are made up of materials that were deposited in environments and systems similar to those that are observed to be active in the area today (Fisher and others 1972).

The Texas coastal plain is composed of sediment ranging in age from late Eocene to Recent epochs. The Recent Epoch system is oriented as bands parallel with the coast, that is, the strike of the sedimentary beds is generally parallel to the coast or northeast to southwest. As the dip angle and bed thickness increase towards the coast, the clastic materials also transition in character gradationally from sands, to silts, to dominating clays.

3.1.2 Topography

The topography of the Houston area is relatively flat with elevations decreasing gradually from west to east and the land surface sloping gently in the direction of Buffalo Bayou (Fisher and others 1972). The site topography is nearly level with elevations of 40 to 45 feet above mean sea level.

Drainage from the site discharges to shallow ditches along Knight Street and Mansard Street. A storm drain at the intersection of Knight Street and Interstate Highway 610 collects and carries stormwater northward along Knight Street about 1.6 miles to Brays Bayou, then discharges into Buffalo Bayou, the San Jacinto River and eventually into Galveston Bay (Radian 1988a).

3.1.3 Meteorology

Proximity to Galveston Bay and the Gulf of Mexico affects the climate of the site and surrounding area, resulting in mild weather conditions and an average daily temperature of 70°F. The average daily low temperature is 43.6 °F during the month of January. The average daily high temperature is 92.8 °F occurring generally during August. The average total annual precipitation for Harris County is 46 inches with recorded annual extremes of 92.6 inches in 1900 and 17.7 inches in 1917 (USDA 1976). The mean annual lake evaporation for the area is approximately 18 inches (Bomar 1983).

Two principal wind regimes are present in the Texas Coastal Zone, southeasterly winds from March through November, and intermittent northerly winds from December through February. Prevailing winds in Harris County are from the south-southeast. The highest average wind speeds generally occur during the month of April. The strongest seasonal winds in the area are produced by winter polar air masses arriving from the north, producing wind speeds of 20 to 40 miles per hour over a time period of 12 to 36 hours (Bomar 1983).

The most severe weather occurring in Harris County is produced by hurricanes and tornadoes. Only 20 miles from the Gulf of Mexico, the Harris County area has an estimated one in eight chance of being affected by direct landfall of a hurricane in any given year; historically, the area is struck by a tornado approximately every other year (Bomar 1983).

3.2 REGIONAL AND SITE GEOLOGIC CONDITIONS

The regional and site geologic conditions are described in this section.

3.2.1 Regional Geologic Conditions

The Texas Coastal Zone is underlain by thousands of feet of sand and clay (coastal plain) deposits, which are mostly unconsolidated (Groat 1976). Plio-Pleistocene sediment of the Texas Gulf Coast were deposited in fluvial, deltaic, and marine environments. Short-term, glacio-eustatic sea level oscillations resulted in a complex but compressed stratigraphic record (Fisher 1988). Upper units of Plio-Pleistocene age that crop out in the Texas coastal plain consist primarily of interbedded mud, sand, and gravel facies of fluvial-deltaic origin (Groat 1976).

Table 3-1 provides a summary of the uppermost stratigraphic units underlying the Houston area. These units are also represented on Figure 3-1, a regional geological cross section. The Sol Lynn/ITS site is directly underlain by the Beaumont Formation of the Pleistocene Epoch which consists of former barrier island and beach deposits. The Beaumont Formation is made up of clay, silt and sand formed from stream channel, point-bar, natural levee, backswamp, coastal marsh, and mud flat deposits. The Beaumont Formation contains calcium carbonate concretions, iron oxide, and iron-manganese nodules in zones of weathering. In the site vicinity, the Beaumont Formation is described as consisting mainly of clay and mud of low permeability with a high water storage capacity. The Beaumont Formation is estimated to be up to 500 feet thick (Fisher 1982). According to Fisher and others (1972), the Beaumont

Formation, directly underlying the site, is made up of fluvial deltaic system deposits consisting of abandoned, mud-filled channels, and courses (Radian 1988).

In the Houston area, the Beaumont Formation is underlain by the Lissie Formation, which is also of Pleistocene age. The lithology of the Lissie Formation consists of clay, silt, sand, and minor amounts of siliceous gravel. The Lissie Formation is approximately 200 feet thick (Fisher 1982).

Underlying the Lissie Formation is the Willis Formation of the Plio-Pleistocene age. The Willis Formation is similar to the overlying Lissie Formation in lithologic character except that it contains petrified wood and the sands within it are coarser than in younger units above. The Willis Formation is approximately 75 feet thick (Fisher 1982).

The Willis Formation is underlain by the Goliad Formation (30 to 2,000 feet thick) and the Lagarto Formation (1,400 to 1,700 feet thick). Both of these formations are of Miocene age and were deposited in fluvial environments. The Goliad Formation consists primarily of sand, while the Lagarto Formation consists of mud and sand (Fisher 1988).

The Houston area has experienced regional subsidence that has been attributed to ground water withdrawals in the Texas coastal plain. Topographic lineations mapped in the Texas Coastal Zone (Groat 1976) primarily represent the traces of faults originating in Tertiary Period sediment and propagating upward through Quaternary Period sediment. Fault movement in the Houston area is also being activated and accelerated by ground water withdrawals. The Texas coastal plain and the underlying portion of the Gulf Coast basin compose a structural province characterized by growth faulting with very low levels of seismic activity. These faults actively displace the land surface in the Houston-Galveston area (Groat 1976). Other faults in the area are due to the presence of salt diapirs or salt domes (Radian 1988).

Growth faults are commonly associated with deltaic deposits, especially large, river-dominated, high-mud delta systems. The principal zones of growth faults are approximately at the boundary between the delta front sands and the thick, rapidly deposited, prodelta mud facies. Increased consolidation of the thick, highly compressible mud facies facilitates fault development. Sections often double in thickness across the growth faults with the greater sediment thickness in the prodelta muds (Groat 1976).

Several types of faults result from salt diapirs or salt domes penetrating overlying sediment accumulations. These include normal faults with single or normal offsets, grabens, horsts, radial faults, tangential faults, and thrust faults. These faults are generally steeply dipping and occur close to the salt dome. The site is located very close to a salt dome in the subsurface (Radian 1988).

3.2.1.1 Soil

Soil types in the vicinity of the site are classified as Lake Charles-Urban Land Complex (Lu), which is a mixture of soil types described as 20 to 85 percent Lake Charles soil, 10 to 75 percent Urban Land soil, and 15 percent or less other soils (USDA 1976).

Lake Charles soil is nearly level soil with slopes of 0 to 1 percent. The Lake Charles mapping unit includes small areas of Beaumont (clay), Bernard (clay loam), Midland (silty clay loam), Addicks (loam), and Vamont (clay) soil types. The soil is described as being poorly drained with slow surface runoff due to the high clay content in the soil. As a result, soil permeability and internal drainage are also slow. A high shrink-swell potential and high available water capacity are also characteristics of this soil due to the clay content (USDA 1976).

Urban Land soil occurs in extensively built up areas where 75 to 100 percent of the area is covered by structures or where the soil has been redistributed by cutting, filling, or grading activities. Urban Land soils are more difficult to classify because they have been altered (USDA 1976).

3.2.2 Site Geological Setting

The site geology has been characterized using boring logs from 35 monitoring wells and 30 extraction and recharge wells drilled in the site vicinity, including eight deep wells installed approximately 100 feet below the ground surface. Figure 3-2 shows the monitoring well locations. A schematic stratigraphic column showing lithological zones encountered at the site is demonstrated in Figure 3-3. Figures 3-4 and 3-5 are hydrogeologic cross sections showing the site hydrostratigraphy in south to north (Cross Section A-A') and west to east (Cross-Section B-B') orientations, respectively. The cross section locations are also shown on Figure 3-2.

As shown on Figure 3-3, the site stratigraphy consists of a section approximately 100 feet thick of very fine-grained materials, composed of interbedded mud (silt), clay, and silty clay with several relatively thin, continuous silty sand and sand horizons. Discontinuous silty sand horizons are also present, particularly in the lower part of the section.

From the surface down to a depth of approximately 10 feet, stiff clay with calcareous nodules and iron concentrations occur. From 10 to 15 feet bgs, slickenside fractures have been observed in the clay. The clay varies in color from brownish gray to gray in the uppermost few feet to a stiff red clay, typically mottled gray, tan, and brown. From 15 to 20 feet bgs, the clay contains higher proportions of silt. At depths ranging from 18 to 23 feet bgs, a thin zone of saturated interbedded silty sand; sandy silt; and silty, sandy clay interrupts the uppermost clay. The silty sand and sandy silt interval has been termed the "silty zone" in previous reports. The sand in this zone is typically gray to reddish brown in color and fine- to very fine-grained. At depths of about 23 feet, a stiff reddish clay, mottled gray or orange, is encountered (Radian 1994).

Figure 3-6 is an isopach map of the silty zone which occurs approximately 18 to 23 bgs. The contoured thickness values shown on Figure 3-6 indicate that the silty zone is thickest on the site (3 to 4 feet) but these thicknesses are limited in extent. The contour lines suggest that under the site the thickness variations are more extreme whereas to the north the thickness decreases gradually to about 0 to 1 foot. From the isopach map presented in Figure 3-6, the silty zone can be interpreted to possibly pinch out to the northeast and southwest of the site.

Between depths ranging from 20 to 30 feet, stiff clay with slickenside fractures and silty clay are interbedded with discontinuous stringers of fine grained silty sand. At a depth of approximately 30 feet bgs, a fine-grained silty sand unit with some interlayered clay is present (Radian 1994). This unit varies in composition and apparently increases in thickness from west to east at the site, ranging from approximately 1 foot at the western end of the site to about 7.5 feet at the eastern end of the site. Sand content also increases from west to east across the site (Radian 1988). Figure 3-6 is an isopach map of the coarser part of silty sand unit occurring at a depth of approximately 30 feet. The isopach map shown on Figure 3-6 indicates that the thickness of the coarser silty sand unit (30 to 33 feet bgs) is greatest (8.5 feet) just north of the eastern end of the site. The contour lines suggest that the unit becomes thinner (to 1 to 2 feet) in the western part of the site. The isopach map also suggests that the unit is continuous on the site and to the north, beyond the site. Below this silty sand unit from about 30 to 40 feet bgs, fine-grained silty sand with interlayered clay, occasional gravel, and calcareous nodules occurs.

Underlying the fine-grained silty sand at about 35 to 40 feet, an approximately 40- to 50-foot-thick layer of primarily red and green mottled stiff clay to silty clay occurs of which the top 10 feet (40 to 50 feet bgs) consists of sandy silt. North of the site, a discontinuous sandy silty zone is encountered at approximately 51 feet bgs.

Fine to very fine sands and sandy silts are again encountered between about 80 to 90 feet bgs (Radian 1994). The lithology of this zone consists of very fine to fine sand and sandy silt. This zone is underlain by stiff clay to a depth of at least 100 feet bgs.

3.3 REGIONAL HYDROGEOLOGY

Coastal aquifers in the greater Houston area are composed primarily of fluvial-deltaic sediments (Kreitler and others 1977). Shallow (less than 3,000 feet bgs) subsurface sands that are charged with fresh water, constitute the most important aquifers (Groat 1976).

Near the Texas Gulf Coast, directions and rates of ground water flow are controlled partly by aquifer geometry and geologic history. Strike-oriented growth faults and dip-oriented, high percent sand unit trends may localize the effects of high ground water pumpage. Dip-oriented sands in high-percent sand units are optimum horizons for ground water production. The dip-oriented sand trends are parallel to the regional hydraulic gradient, which also should facilitate additional recharge from the stratigraphically updip section. Dip-oriented sand trends occur in western Harris County (Kreitler and others 1977).

3.3.1 Hydrostratigraphy

The two uppermost regional aquifers present in the Houston-Galveston area, the Chicot and underlying Evangeline, are composed of alternating beds of clay, silt, sand, and gravel deposited in a series of fluvial-deltaic environments that were affected by rapid changes in sedimentation rate, regional subsidence of the Gulf of Mexico, and changes in mean sea level since at least the end of the Tertiary Period (Figure 3-1). This variation occurs both laterally and vertically and makes differentiation of individual beds and correlation of them more complex. While both aquifers contain sands and clays, the sands of the Chicot aquifer are generally more permeable, and the clays are of a more compressible type than those of the Evangeline aquifer. Differences in the hydraulic conductivity contribute to the differences in the potentiometric levels observed in the two aquifers (Radian 1988). The Chicot aquifer is the major aquifer in the vicinity of the site. In nearby Galveston County, the Chicot aquifer is the major source of ground water (Radian 1988). The Evangeline Aquifer is underlain by the Burkeville aquitard. Table 3-1 presents the regional upper hydrogeologic units underlying the Houston area. Figure 3-1 is a regional cross section showing the relationship between regional hydrostratigraphic units in the area.

Chicot Aquifer

The Chicot aquifer is composed of the Beaumont and Lissie Formations of Pleistocene age, as well as the overlying Holocene-age alluvium, where present (Radian 1988). In some areas, the Chicot aquifer consists of one to four laterally discontinuous sand units (Beaumont Formation) which constitute the upper Chicot aquifer, underlain by the lower Chicot aquifer (Lissie Formation), which is one continuous sand body. Sand bodies in the upper Chicot aquifer are variable in thickness and lateral continuity. Sands of the upper Chicot aquifer are typically less than 100 feet thick, although they coalesce locally, forming thicker bodies. Lenticular geometries are common (Hamlin and others 1988). In the northern part of Harris County, the Chicot Aquifer is undifferentiated, however in the vicinity of the site, the two sub-units, an upper and a lower, of the Chicot can be defined from well logs and water level data (Radian 1988).

A hydraulic conductivity of 50 feet per day (ft/day) has been reported for the Chicot aquifer (Hamlin and others 1988). The transmissivity (T) of the Chicot aquifer is estimated to range from 1.0 to 20,000 square feet per day (ft^2/day). The storage coefficients (S) reportedly range from 0.004 to 0.20, with higher values reported in the northern portion of Harris County and adjacent Montgomery County.

Evangeline Aquifer

The Evangeline aquifer, consisting of materials of the upper Miocene to Pliocene epochs aged-materials is a thick, sand-dominated interval occurring below and the Chicot aquifer. The Evangeline aquifer is generally composed of the Willis and Goliad formations. The uppermost sands of the Evangeline aquifer are separated from the overlying Chicot aquifer by a continuous mud to sandy mud that is 30 to 200 feet thick. Several thinner, less continuous sands and muds separate the lower part of the Evangeline from the underlying Burkeville aquitard. In some areas, the Evangeline aquifer may contain brackish water (Hamlin and others 1988).

Hydraulic conductivities of 33 and 43 ft/day were reported for the Evangeline aquifer (Hamlin and others 1988). Transmissivities of the Evangeline aquifer range from less than 5,000 to 15,000 ft^2/day. Where the aquifer is under water-table conditions, such as in the outcrop area, the storage coefficient ranges from 0.002 to 0.2. The updip portion of the Evangeline aquifer, located in Harris County, produces fresh water, which is a major drinking water source. The Evangeline aquifer becomes brackish or saline towards the south in Galveston County (Radian 1988).

Burkeville Aquitard

The Burkeville aquitard, consisting of lower permeability materials that are upper Miocene in age is a generally fine-grained interval that typically corresponds to the Lagarto Formation. Regionally, the Burkeville aquitard is identified as being the first interval with low sand content below fresh to brackish water in the Evangeline aquifer (Hamlin and others 1988).

3.3.2 Hydrology

Surface water nearest the site consists of Brays Bayou, trending northeast to southwest, approximately 1.6 miles to the north. Brays Bayou flows to the northeast into Buffalo Bayou; with the confluence located approximately 4 miles northeast of the site. Buffalo Bayou is a dredged channel that serves as a ship canal for the Port of Houston. Buffalo Bayou flows southeastward into the San Jacinto River, approximately 12 miles southeast of Houston (Fisher and others 1972).

Brays Bayou, which drains approximately 95 square miles, including the Sol Lynn/ITS site, has high average run-off because it drains the Beaumont Formation where rainfall infiltration is much slower than in sandier soil (Radian 1988).

3.4 SITE HYDROGEOLOGY

Shallow ground water at the site occurs within the more permeable units of the Beaumont Formation, which underlies the site. The surficial hydrogeologic units at the site are part of the upper Chicot aquifer, described in Section 3.3 and presented in Table 3-1 and on Figure 3-1. The site hydrostratigraphic nomenclature has evolved through investigative activities as additional hydrogeologic data was acquired. Aquifer nomenclature and divisions are based on aquifer characteristics and the presence of intervening aquitards.

Different nomenclature has been used for the surficial hydrostratigraphic units at the site throughout the previous site investigations. For purpose of consistency and reflection of aquifer characteristics, this technical memorandum proposed a revised hydrostratigraphic designation of site unit nomenclature to be used throughout the remainder of the work assignment. Table 3-2 presents the correlation between previous hydrostratigraphic nomenclature and the revised nomenclature developed for this technical memorandum. Five hydrostratigraphic units in addition to the vadose zone are defined as the surficial aquifer system to a depth of approximately 100 feet bgs at the site. Three aquifers are composed of silty sand and sand and are separated by two aquitards composed of clay and silty clay. The shallow aquifer is separated from the intermediate aquifer by the upper aquitard; the intermediate aquifer is separated from the deep aquifer by the lower aquitard.

At the site, stiff clay with calcareous nodules extends from the surface to a maximum depth of approximately 18 feet bgs. This clay varies in color from brownish gray to gray in the upper few feet, to a stiff red clay, typically mottled gray, tan, and brown. Iron-oxide pockets and nodules are common (Radian, 1988). The potentiometric surface is present at depths ranging from 5 to 14 feet bgs.

Clay alternating with beds of silty clay and sandy silt extends from a depth of 15 to 30 feet. The shallow aquifer is a silty sand horizon occurring at depths of 18 to 23 feet. The shallow aquifer was previously designated as the Silty Zone/sand (Radian 1998) and the 20-foot zone/sand (Radian 1999). Furthermore, the shallow aquifer (Silty Zone) was previously designated as the upper portion of the Upper zone/sand (Radian 1994).

In the central portion of the site (well FGB-1), the shallow aquifer zone occurs as a 4-foot-thick, coarse-grained sand with up to 3-inch-thick clay lenses. Immediately south of the eastbound access road to highway I-610 (well MW-25), the zone is 4.5 feet thick and composed of very fine to fine-grained silty sand. Immediately north of Mansard Street south of the site (well MW-26), the zone consists of interbedded sandy silt and clay. Immediately south of the eastbound access road to highway I-610 in the western portion of the site (well MW-24), the zone consists of 7.5 to 8.5 feet of silty clay to silty sand with interlayered and interlaminated clay, and is underlain by stiff clay with interbedded silt. Between the eastbound access road and highway I-610, northwest of the site (well MW-13), the zone is described as 5 feet thick and composed of silty clay with a thin gravel layer. Figure 3-6 is an isopach map illustrating the occurrence and variations in thickness of the shallow aquifer (silty zone). The shallow aquifer is 3 to 4 feet thick under the site and thins to 0 to 1 foot to the north of the site. The shallow aquifer may be discontinuous northeast and southwest of the site.

The shallow aquifer is underlain by the upper aquitard, which is composed of approximately 10 feet of clay to clayey silt at approximately 23 to 33 feet bgs. A discontinuous silt layer occurs in some areas within the upper aquitard at an approximate depth of 25 to 27 feet (Radian 1994). Pumping and slug test data indicate that this aquitard is either not continuous or leaky and that the shallow and the underlying intermediate aquifer are in hydraulic communication.

The intermediate aquifer occurs beneath the upper aquitard at an approximate depth of 33 to 40 feet below ground surface and was previously designated as the Uppermost Aquifer (Radian 1988), Upper Zone/Sand (Radian 1994), and the 40-foot zone/sand (Radian 2000). Furthermore, the intermediate aquifer was also designated as the lower portion of the Upper Aquifer with the silty zone as the upper portion of the Upper aquifer (Radian 1994).

The intermediate aquifer consists of fine-grained silty sand with some interlayered clay and ranges from 1 to 9 feet thick. Figure 3-6 is an isopach map showing the areal extent and thickness distribution of the intermediate aquifer. The thickness of the intermediate aquifer is greatest (7.5 feet) in the eastern part of the site and may be continuous in the site vicinity.

The intermediate aquifer is underlain by approximately 40 feet of clay to silty clay. A discontinuous silt layer occurring at a depth of 41 to 45 feet and may be hydraulically connected with the intermediate aquifer in some areas (Radian 1994). This clay or silty clay unit is referred to as lower aquitard in this report.

The lower aquitard, underlying the intermediate aquifer, is mainly composed of stiff clay with several discontinuous sandy silt zones at approximately 50 feet bgs; however, these zones have only been detected north of the site. Other occasional silt layers also were encountered in the lower aquitard down to a depth of 78 feet (Radian 1994). The discontinuous silty layers or sand lenses were previously designated as the 60-foot zone (Radian 2000). Because the sandy silt and silt layers occur in laterally and vertically discontinuous zones that are limited in extent, the interval is interpreted to act as an aquitard in this report.

The deep aquifer underlies the lower aquitard at a depth of about 78 feet bgs. The deep aquifer is composed of sandy silt or silty sand with a thicknesses of approximately 5 to 10 feet. The deep aquifer is underlain by stiff clay to a depth of at least 100 feet bgs.

3.5 GROUND WATER FLOW IN THE SURFICIAL AQUIFER SYSTEM

Static ground water elevations measured at the site have ranged between 35 and 40 feet above mean sea level. The potentiometric surface generally occurs at depths of about 9 to 14 feet bgs in the shallow and intermediate aquifers and 30 to 35 feet bgs in the deep aquifer wells. This section discusses ground water flow directions in each of the three aquifer zones according to the date of the water-level data collection. In general, the natural flow direction of ground water at the site is towards the north to northwest. Ground water flow directions at the site may be influenced by water wells pumping in the area (Section 3.9) or by Brays Bayou, which drains the Beaumont Formation and flows to the northeast about 1.6 miles north of the site.

3.5.1 Shallow Aquifer Zone

The ground water flow direction in the shallow aquifer has been measured several times since 1993, when it was first characterized as a separate water-bearing zone (Radian 1993). The ground water flow direction in the shallow aquifer has been rather consistently toward the north-northwest. Figure 3-6 is a ground water elevation contour map drawn from data collected on January 18, 1993, and showing a hydraulic gradient that is representative of most water-level elevation data previously collected for the shallow aquifer. In 1993, data from a baseline sampling event (SWL 1993) indicated a south-southeast ground water flow direction; however, the gradient reversal, as interpreted, was based on only two data points, which may have been anomalous.

The 1993 round of water level data mentioned above was the last full round prior to the initiation of the ground water extraction system in September 1993. A round of water-level elevation data was collected in November 1998, approximately 2 years after the system had been shutdown and just prior to system restart; however, the data set indicates inconsistencies with prior static water-level data, and the potentiometric surface may have been influenced by tests of the system prior to start up.

3.5.2 Intermediate Aquifer Zone

Ground water flow in the intermediate aquifer has been measured a number of times with the result that the ground water flow direction under static conditions is consistently to the north-northwest. Figure 3-8 is a representative ground water elevation contour map drawn for the intermediate aquifer using data collected on January 18, 1993.

3.5.3 Deep Aquifer Zone

In measurements collected since 1988, the ground water flow direction in the deep aquifer under static conditions appears to have been more inconsistent than in the overlying aquifers, probably because of limited data points. In general, a west to northwest flow direction can be interpreted based on March 1991 data. The water-level elevation data suggest that gradient reversals may occur and may be due to natural conditions or to the possible influence of pumping wells near the site. Figure 3-9 is a ground water elevation contour map for the deep aquifer using data from March 1991. The west to northwest flow direction is fairly representative of ground water in the deep aquifer.

3.6 AQUIFER HYDRAULIC CHARACTERISTICS

Aquifers under investigation at the site include the shallow, intermediate, and deep aquifers as described in Section 3.4. Available information from previous investigations regarding hydraulic parameters of these aquifers is presented in Table 3-3 and summarized in this section. Three aquifer pumping tests were conducted during the remedial design sampling program. Two tests were conducted in the intermediate aquifer; one test was conducted in the deep aquifer (Radian 1991).

The shallow aquifer has an estimated hydraulic conductivity of 3.8 ft/day with ground water moving at an estimated velocity of 10.5 feet per year, assuming a hydraulic gradient of 0.00265 and a porosity of 0.35 (Radian 1994). The shallow aquifer is likely under semi-confined condition. Aquifer storativity is estimated to range from 0.0002 to 0.00002 (Radian 1994).

The intermediate aquifer is the most permeable aquifer and has a geometric mean hydraulic conductivity of 25.54 ft/day with an estimated ground water velocity of 106 feet per year (Radian 1994). This calculation is based on a hydraulic gradient of 0.0034, a porosity of 30 percent, and the Hantush method results for an aquifer pumping test conducted in monitoring well MW-11 (Radian 1994). The intermediate aquifer is under confined conditions and the aquifer storativity is estimated to range from 0.0002 to 0.00002 (Radian 1994).

Hydraulic conductivity data have not been collected from the more permeable zones within the lower aquitard as monitoring wells screened in that zone have not been used for aquifer testing (Radian 1994).

The hydraulic conductivity of the deep aquifer ranges between 0.3 to 0.9 ft/day and the transmissivity ranges from 1.6 to 5.7 ft^2/day. The hydraulic gradient averages 0.0083 ft/ft, based on westward flow measurements (Radian 1988).

3.7 BOUNDARY CONDITIONS AND INTERRELATIONSHIPS OF THE AQUIFER ZONES

Lateral boundaries were not identified for the surficial aquifer systems at the Sol Lynn/ITS site. Pumping tests (Radian 1994) demonstrated that the shallow aquifer is hydraulically connected to the intermediate aquifer through the upper aquitard. The thickness of the upper aquitard that separates the shallow and intermediate aquifer zones varies at the site and the integrity of the upper aquitard is questionable. Vertical gradients between the two zones are estimated at 0.0 to 0.167 ft/ft in a downward direction (Radian 1994).

Vertical hydraulic connection between the intermediate and deep aquifer zones is unknown. The lower aquitard is a relatively thick layer of clay and silty clay. It is expected to behave as a hydraulic barrier between the intermediate and deep aquifer zones. However, contaminant data indicate that some hydraulic connection between the two aquifer zones exist. The hydraulic interrelationship between the intermediate and deep aquifer zones remains a major data gap and should be further characterized through aquifer hydraulic testing, analysis of ground water hydrography, and possibly a tracer study.

3.8 GROUND WATER GEOCHEMISTRY

Hydrochemical facies observed in ground water in the Texas Coastal Zone aquifers indicate recharge in northern Harris County and discharge in southern Harris County. The evolution of sodium bicarbonate waters in Harris County occurs through cation clay exchange in a closed carbonate system with no additional carbon dioxide source (Kreitler and others 1977). The Chicot aquifer yields water that is higher in calcium bicarbonate ("hard" water), and the Evangeline aquifer produces sodium bicarbonate type ("soft" water). Both aquifers contain only moderate amounts of total dissolved solids (Radian 1988).

Ground water geochemistry of the surficial aquifer system at the Sol Lynn/ITS site is has not been adequately characterized, and this remains as a major data gap for the site characterization.

3.9 GROUND WATER USE IN THE VICINITY OF THE SITE

The city of Houston's water supply is from ground water withdrawals, mostly from the Evangeline Aquifer, and surface water from Lake Houston. The southeastern portions of Harris County and Galveston County are supplied by ground water from the Chicot Aquifer (Radian 1988).

Water wells located within a 2-mile radius of the site were identified using an Environmental Data Resources (EDR) database search, past site investigation reports, and ground water data for Harris County, Texas, driller's logs of wells (dated 1905-1971). The inventory indicated that 50 wells (Table 3-4) potentially exist within 2 miles of the site. Information in Table 3-4 includes well owner, installation date, and total depth. Wells listed in Table 3-4 were completed at depths ranging from 68 to 702 feet. The reported use of these wells includes residential water supply wells and industrial supply wells.

According to the EDR (2000) report, 12 water wells were identified for domestic use, and 10 of the wells were drilled and recorded for industrial use. The remaining supporting reports did not have clear documentation designating the use of the additional recorded drilled wells. A copy of the EDR water well report is included as Appendix A.

3.10 SUMMARY OF HYDROGEOLOGICAL CONCEPTUAL MODEL

The Sol Lynn/ITS site is situated in low permeability materials of the Beaumont Formation. In the approximately 100-foot depth that has been investigated at the site, the Beaumont Formation consists primarily of clay and silty clay with several thin, silty sand or sandy continuous stratigraphic horizons that are designated as aquifer zones in the surficial aquifer system, identifiable based on lithologic characteristics. Discontinuous sand lenses are also present in the clay. The surficial aquifer at the site belongs to the upper portion of the upper Chicot aquifer, a regional water-bearing zone.

The site hydrogeological conceptual model can be summarized as follows:

- The surficial aquifer system is composed of five hydrostratigraphic units below the vadose zone soil (from top to bottom): the shallow aquifer, the upper aquitard, the intermediate aquifer, the lower aquitard, and the deep aquifer.
- The shallow aquifer zone, which was also named the "silty zone" or "20-foot zone" in the previous investigations, is at approximately 18 to 23 feet bgs and generally 4 to 5 feet thick.
- The upper aquitard generally occurs at 23 to 33 feet bgs. The thickness, integrity and lateral extent of the unit may vary significantly cross the site.
- The intermediate aquifer zone, which was also named the "uppermost aquifer" or "upper sand" or "40-foot zone" in the previous investigations, is at approximately 33 to 40 feet bgs. The average thickness of the intermediate aquifer zone is about 5 to 6 feet.
- The lower aquitard, occurring at 40 to 80 feet bgs, is mainly composed clay or silty clay. Some discontinuous sand or silt lenses may exist from 43 to 60 feet. The sand or silt lenses was named the "60-foot zone" in the previous investigations.
- The deep aquifer zone, which was also named the "intermediate aquifer", "intermediate sand", or "80-foot zone" in the previous investigations, occurs at about 80 to 90 feet bgs. The deep aquifer is generally 5 to 7 feet thick.

- Ground water is likely under semi-confined conditions in the shallow aquifer zone, and confined conditions in the intermediate and deep aquifer zones.

- The upper aquitard behaves as a leaky aquitard that potentially interconnects the shallow and intermediate aquifer zones. The lower aquitard may also be a leaky aquitard, however, the leakage through the lower aquitard could be significantly smaller than that through the upper aquitard. The vertical hydraulic properties of the both aquitards are unknown.

- Ground water flow in the surficial aquifer system is complex because the three aquifers are highly heterogeneous. In general, the steady-state ground water flow in all three aquifers are toward north or northwest, based on limited water level data of poor quality.

- Aquifer hydraulic properties were inadequately characterized. In general, the intermediate aquifer is the most permeable of the three aquifers with an average hydraulic conductivity (K) of 26 ft/day. The deep aquifer is the least permeable with a K value of 0.5 ft/day. The shallow aquifer K is approximately 3.8 ft/day.

- No major lateral boundaries were identified for the surficial aquifer system.

- Ground water geochemistry in the surficial aquifer system is unknown.

- Recharge of the surficial aquifer system is likely from lateral ground water flux and vertical infiltration through storm water drainage leak. Surface infiltration is not likely to be significant because the surrounding vicinity of the site is paved.

- The shallow and intermediate aquifer zone are likely interconnected hydraulically through the upper aquitard. The interconnection between the intermediate and deep aquifer zones is possible but in less extent.

3.11 IDENTIFICATION OF DATA GAPS

Significant data gaps remain regarding the site hydrogeological characterization, based on the above discussion. In general, the following data gaps should be filled during the supplemental RI/FS investigation:

- Aquifer heterogeneity, especially for the shallow and intermediate aquifer zones, should be further characterized through CPT technologies or borings.

- Lower aquitard should be further characterized to identify whether the 60-foot zone can be characterized as a water-bearing zone.

- Static ground water level data reflecting the natural flow patterns in all three aquifers should be collected and ground water potentiometric maps should be generated.

- Ground water level data under the ground water extraction and treatment system operation conditions should be collected to characterize the capture zone and hydraulic effects of the system operation.

- Aquifer hydraulic tests should be conducted in the shallow, intermediate, and deep aquifer zones to further characterize: (1) aquifer horizontal and vertical hydraulic properties, and (2) interrelationships between the aquifer zones.

- Ground water geochemistry data include basic cation and anion concentrations, aquifer redox potentials, TDS, dissolved oxygen and other geochemical parameters should be collected.

- Ground water recharge to the shallow, intermediate, and deep aquifer zones should be further evaluated. Discharge or ground water usage data should also to be compiled.

- A refined three-dimensional ground water flow model should be developed to further understand the flow pattern under different remediation scenarios and to help characterize contaminant migration.

4.0 SITE CONTAMINANT MIGRATION CONCEPTUAL MODEL

Soil and ground water at the Sol Lynn/ITS site are contaminated with chlorinated solvents, primarily TCE. This section summarizes and interprets the chemical data that have been collected to characterize the chlorinated solvent contamination at the Sol Lynn/ITS site. Section 4.1 presents a characterization of contaminant sources. Section 4.2 discusses potential offsite sources of contamination. Section 4.3 addresses the effects of contaminant source removal and contamination control. Section 4.4 presents the nature and extent of contamination. Section 4.5 evaluates the presence and effects of DNAPL. Section 4.6 presents a temporal trend analysis of chemical data for individual wells. Section 4.7 discusses contaminant fate and transport processes. Section 4.8 provides a preliminary evaluation of the potential for natural attenuation of the chlorinated solvent contamination in ground water. Section 4.9 summarizes the conceptual model of contaminant migration for the Sol Lynn/ITS site. Section 4.10 identifies data gaps.

4.1 CONTAMINANT SOURCE CHARACTERIZATION

Characterization of the sources of chlorinated solvent contamination is important for understanding the migration of the contamination from soil to ground water and for developing a valid contaminant migration conceptual model. The primary sources of the contamination at the Sol Lynn/ITS site, that is, whether it was caused by spills, leaky pipes or tanks, or disposal, is unknown. Secondary sources, that is contaminated soil, can be characterized with analytical data. This section presents surface and shallow subsurface soil analytical data and compares them to analytical data for shallow aquifer ground water and discusses the characterization of contaminant sources based on those data. Potential DNAPL sources of ground water contamination are discussed separately in Section 4.5.

Figure 4-1 was generated based on limited soil sampling data that were collected from 1981 to 1988. The figure shows soil TCE concentrations at or near ground surface (up to 5 feet bgs). In Figure 4-1, soil contamination areas are defined based on soil TCE concentrations that exceed 50 mg/kg. The value of 50 mg/kg was selected because it conveniently defines several areas of elevated soil contamination.

Soil contamination area A is well-defined by data in and surrounding the area and its dimensions are approximately 100 feet by 50 feet. The boundaries of soil contamination area B are not defined to the north, west, and east. The dimensions of area B estimated by the existing data are approximately 100 feet by 30 feet. The highest soil concentration (510 mg/kg) was detected in the northern portion of the area B. A building (approximate footprint dimensions of 100 feet by 75 feet) covers an area immediately east of area B. No soil analytical data are available within the building footprint. Also, documentation could not be found regarding the potential use and disposal of TCE within the building.

The boundaries of soil contamination area C are not well-defined to the west and south. The dimensions of area C defined by the existing data are approximately 40 feet by 30 feet. Figure 4-1 shows four smaller soil contamination areas (exceeding 50 mg/kg), none of which are well-defined.

TCE ground water analytical data from September 1993 are used to represent baseline ground water contamination (before the ground water extraction and treatment system began operating in the same month.) Figure 4-2 shows the configuration of the baseline shallow aquifer TCE plume. A comparison of the locations of soil contamination areas A and B (Figure 4-1) to the configuration of the shallow aquifer TCE plume indicates that areas A and B are likely sources of the shallow ground water TCE contamination. No shallow aquifer data exist in the vicinity of soil contamination area C. The September 1993 ground water TCE plume in the shallow aquifer and the source areas defined by the soil TCE concentrations are consistent with the northwestward ground water flow direction in the shallow aquifer.

4.2 POTENTIAL OFF-SITE SOURCES OF CONTAMINATION

Identification of potential off-site sources of contamination will aid in understanding the nature and extent of contamination and in more precisely developing the site conceptual model of contaminant migration. Potential ground water contamination from these sources could possibly commingle with the ground water contamination from the Sol Lynn/ITS site.

A review of historical aerial photographs covering an area within approximately one-quarter mile of the Sol Lynn/ITS site boundaries was performed. Aerial photographs from 1962 and 1975 indicate a small commercial facility located immediately south of the Sol Lynn/ITS site across Mansard Street; the facility consists of a main building, a parking area, and several smaller buildings. Aerial photographs from 1980 show a larger facility southwest of the Sol Lynn/ITS site; this facility appears to be a light industrial park.

Sampled

Source

Detection of TCE at 50 mg/L was reported for a sample from a water supply well collected by the City of Houston Health Department in 1981 at 2032 Mansard Street. The EDR search identified this facility at this address as operated by Southwestern Bell Telephone Company, a RCRA small quantity generator. Based on the address and the EDR search information, this well is believed to be located approximately one-eighth mile southwest of the Sol Lynn/ITS site.

A search of state and federal environmental databases was conducted to identify potential off-site sources of contamination within a one-mile radius of the Sol Lynn/ITS site. All data have been updated since October 1, 1999. The database only contains registered sites; other off-site sources of contamination with potential impact to the Sol Lynn/ITS site may exist. The results of the database search follow.

The Resource Conservation and Recovery Information System (RCRIS) distinguishes small quantity generators (SQG) and large quantity generators (LQG), depending on the quantity of hazardous waste that is generated, transported, stored, or treated. Five properties located within a one-mile radius of the ITS site are listed in RCRIS; one of these is the Southwestern Bell Telephone Company property located at 2032 Mansard Street discussed above. The other four properties, identified in parentheses as SQGs or LQGs, are as follows:

- Service Industry of America (SQG), approximately one-eighth of a mile west of the site. One compliance evaluation inspection violation was reported.
- Cunningham Auto (SQG), 8600 Knight Road, approximately one-quarter of a mile north-northwest of the site. No violations were reported.
- Federal Sign Company (SQG), located at 8315 Knight Road, approximately one-half of a mile north of the site. Soil contamination was discovered; however, no remedial actions were required and the case was closed.
- Magna Corporation (LQG), located at 2434 Holmes Road, approximately one mile south-southeast of the site. No violations were reported.

The following 11 leaking underground storage tank (LUST) sites are also located within a one-mile radius of the ITS site:

- Al Pan Inc., 1107 South Loop West, is located one-quarter mile east-northeast of the site. Minor soil contamination was discovered at the property after the release occurred in 1991. A final concurrence was issued, and the case was closed.

- South Loop Ford Truck Sales, 8901 Almeda Road, located one-half mile *east-southeast of* the site. The release was detected in 1990, a full site assessment and risk assessment was performed on the property. Final concurrence was issued and the case was closed.

- Almeda Building, 8821 Almeda Road, is located one-half mile east of the site. Soil contamination was discovered on the property. The release was detected in 1991. A full site assessment and risk assessment was performed on the property. Final concurrence was issued and the case was closed.

- AACI-Woodwork Division, 9011 East Almeda Road, located one-half mile east-southeast of the site. A release was detected in 1990, a full site assessment and risk assessment was performed on the property. Final concurrence was issued and the case was closed.

- Shepler Equipment, 9103 east Almeda Road, located one-half mile east-southeast of the site. After a release in 1993, soil contamination was discovered on the property. A full site assessment and risk assessment was performed on the property. Final concurrence was issued and the case was closed.

- Texaco station, 8610 Almeda Road, located one-half mile east-northeast of the site. A leak occurred in 1987 and 1990, ground water was impacted. The 1987 release is documented by an incomplete site characterization report and a final quarterly monitoring report overdue. The 1990 case is closed.

- Chevron Facility #108194, 8550 Almeda Road, located one-half mile east-northeast of the site. Ground water was impacted on the property. No apparent threats or impacts were made on surrounding receptors. A phase 3 investigation is currently in progress.

- State Inspection Plus, 8551 Almeda Road, located one-half mile east-northeast of the site. After the 1992 release minor soil contamination was detected on site. The case was closed.

- Federal Sign Company, 8315 Knight Road, located one-half mile north of the site. Soil contamination was discovered after the 1992 release. No remedial action was required, and the case was closed.

- Stop-N-Go Market #490, located one-half mile north of the site. After the release occurred in 1989, ground water was contaminated. The case has been closed.

- Unidentified site located at 1800 South Loop West 610, located one-half mile west of the site. Ground water was impacted on the property after the 1989 release. No apparent threats or impacts were made on surrounding receptors. The case has been closed.

One state landfill is located within one-half mile of the site. The name of the landfill is not specified in the database. The landfill is located on Houston Knight Road, one-half mile southeast of the site, between highway I-610 and Holmes Road.

Forty-nine State of Texas oil/gas wells are located within a one-mile radius of the site. Typically, oil and gas well production and operations do not produce constituents such as those contaminants found at the Sol Lynn/ITS site; however, activities associated with these operations, such as the use of solvents for equipment maintenance, may involve constituents similar to those found at the Sol Lynn/ITS site.

4.3 SOURCE REMOVAL AND CONTAMINATION CONTROL

Contaminant remediation has been performed at the Sol Lynn/ITS site to remove some soil sources of contamination and to control migration of the ground water plumes, including (1) excavation of contaminated soil, mainly for PCB contamination, (2) extraction and treatment of contaminated ground water, and (3) recharge of treated ground water. These activities have affected the migration of contaminants and are important considerations in the development of a conceptual model of contaminant migration for the Sol Lynn/ITS site.

A previous report by Radian (1988a) indicates that a volume of 2,281 cubic yards of surficial soil (up to 2 feet bgs) contaminated with PCBs and TCE existed at the site. The soils were previously removed and stockpiled at the site. This removal apparently targeted PCB contamination. The report states that the highly contaminated soil was disposed off-site and the remainder was stockpiled for treatment on-site. Soil treatment was reportedly abandoned after the pilot-scale testing. Documentation of all of the source remediation activities, including the soil excavation, off-site disposal of highly contaminated soil, on-site soil treatment and pilot testing, was not found in the project data files and site characterization and remediation report records.

From 1993 to 1999 a total of 15.5 million gallons of contaminated ground water were extracted from the shallow, intermediate, and deep aquifers and a total of 6,061 pounds of TCE were removed by the treatment system (Radian 1996 and 2000). Approximately 15 percent of the treated ground water was re-injected into the shallow and intermediate aquifers from 1994 to 1996 in an attempt to improve the performance of the extraction wells. The ground water extraction may remove limited contaminant mass from the surficial aquifer system; however, the ground water contamination was not under control. The injection system using treated ground water was not well-designed to achieve hydraulic control of ground water plumes. Consequently, the system operation might promote the spread of contamination from the source areas.

4.4 NATURE AND EXTENT OF CONTAMINATION

This section describes the nature and extent of contamination in soil and ground water at the Sol Lynn/ITS site. The discussion in this section focuses on the chlorinated solvent compounds, particularly TCE; contamination of ground water by DCE and vinyl chloride are also discussed. No soil chemical data are available for DCE and vinyl chloride.

Section 4.4.1 discusses TCE contamination in soil. Section 4.4.2 presents the available ground water chemical data used for the data evaluation. Sections 4.4.3 through 4.4.6 present the interpretation of ground water contamination data and discuss the chlorinated solvent plumes in ground water for four different periods: (1) before ground water extraction and treatment system startup in September 1993, (2) after three years of extraction and treatment operation (November 1996), (3) at the end of a two-year shutdown of the extraction and treatment system (November 1998), and (4) nine months after restarting the extraction and treatment system (September 1999).

4.4.1 TCE Soil Contamination

Soil samples were collected and analyzed for TCE during several investigation efforts from 1981 to 1991 (Radian 1988a). Surface soil (0 to 3 inches bgs) and shallow subsurface soil (up to 5 feet bgs) samples were collected between 1981 and 1988 and analyzed for TCE. Figure 4-1 shows soil TCE concentrations for all those surface and shallow subsurface soil samples. In that figure, soil contamination areas are defined based on soil TCE concentrations that exceed 50 mg/kg. Soil contamination area A is well-defined by the soil data and its dimensions are approximately 100 feet by 50 feet. The boundaries of soil contamination area B are not defined to the west, north, and east. The dimensions of area B defined by the existing data are approximately 100 feet by 30 feet. The boundaries of soil contamination C are not well-defined to the west and south. The dimensions of area C defined by the existing data are approximately 40 feet by 30 feet. Figure 4-1 also shows four smaller soil contamination areas (exceeding 50 mg/kg), none of which are well-defined.

Subsurface soil samples below 5 feet bgs and up to 100 feet bgs were collected from several locations from 1987 to 1991 and were analyzed for TCE. The highest soil TCE concentrations among these samples were detected in soil samples from well borings MW-4 and MW-10, both located within soil contamination area

B shown on Figure 4-1. The highest soil TCE concentration at MW-4 (2,000 mg/kg) was detected at a depth of 30 to 35 feet bgs; this interval approximately corresponds to the intermediate aquifer. The highest soil TCE concentrations at MW-10 were detected at the 18- to 20-foot and 23- to 25-foot depth intervals (600 and 400 mg/kg, respectively); these intervals approximately correspond to the shallow aquifer.

4.4.2 Available Ground Water Chemical Data

Ground water contamination has been investigated for the surficial aquifer system (to a depth of approximately 100 feet bgs). Ground water samples have been collected and analyzed since 1981. TCE has been the most frequently analyzed constituent and has been included in virtually all sample analyses. Other constituents analyzed at various times include PCBs, dioxins, furans, PCE, cis-1,2-DCE, vinyl chloride and other VOCs. Since the ground water extraction and treatment system was restarted at the site in December 1998, ground water samples have been analyzed for a full suite of VOCs.

The focus of data interpretation in this report is TCE and its degradation products cis-1,2-DCE and vinyl chloride. Figure 4-3 shows an inventory of the ground water chemical data available for three chlorinated solvent compounds: TCE, DCE, and vinyl chloride since February 1987. In September 1993, baseline sampling was conducted before the ground water extraction and treatment system was started.

The data inventory figure shows that most wells were sampled during six rounds of sampling events: September 1993, November 1994, 1995, 1996, and 1998, and September 1999. During the 3-year period from October 1993 to October 1996, the ground water extraction and treatment system was operated; November 1994 and November 1995 sampling rounds were conducted during the system operation.

Based on the data availability and the ground water extraction and treatment operation, four rounds of the sampling data are selected for interpretation of ground water contamination distributions (mainly TCE) in the surficial aquifer system. The four rounds of sampling are September 1993, November 1996, November 1998, and September 1999 (the most recent sampling round).

Ground water TCE plume maps (Figures 4-2 through 4-14) have been contoured at concentration intervals of 0.005 mg/L, 0.11 mg/L, 11 mg/L, and 550 mg/L. The 0.005-mg/L value is the MCL for TCE. The values 0.11 mg/l, 11 mg/L, and 550 mg/L correspond to 0.01, 1, 10, and 50 percent of the TCE solubility (the solubility of TCE at 20°C is 1,100 mg/L). These intervals were chosen for the convenience of evaluating the possible presence of DNAPL (Section 4.5) which is indicated by dissolved concentrations exceeding one percent of the solubility of DNAPL-forming compounds.

Similarly, ground water cis-1,2-DCE plume maps (Figures 4-15 and 4-16) have been contoured at concentration intervals of 0.07 mg/L, 0.35 mg/L, 35 mg/L, and 350 mg/L. The 0.07-mg/L value is the MCL of cis-1,2-DCE. The values 0.35 mg/L, 35 mg/L, and 350 mg/L correspond to 0.01, 1, and 10 percent of the TCE solubility. The solubility of cis-1,2-DCE at 20°C is 3,500 mg/L.

One ground water vinyl chloride plume (Figure 4-17) was prepared. None of the vinyl chloride concentrations exceed the solubility, but many exceed the MCL (0.002 mg/L). These data have been contoured at concentration intervals of 0.002 mg/L, 0.02 mg/L, 0.2 mg/L, and 2 mg/L.

All of the plume maps are discussed in the following sections.

4.4.3 TCE Plumes in Ground Water Before Extraction and Treatment System Startup (September 1993)

Ground water samples were collected from the shallow, intermediate, and deep aquifer zones in September 1993 before the extraction and treatment system began operating in October 1993. The ground water samples were analyzed for TCE and the analytical results represent a baseline for TCE contamination in the surficial aquifer system at the Sol Lynn/ITS site. Figures 4-2, 4-4, and 4-5 are generated based on the baseline data collected in the shallow, intermediate and deep aquifers, respectively. These plume maps represent the current understanding of ground water contamination distribution for September 1993 with the limited available data.

Shallow Aquifer Zone. Figure 4-2 shows that TCE concentrations exceeded the MCL of 0.005 mg/L in all the shallow aquifer wells sampled in September 1993. The highest detected TCE concentration was 740 mg/L at well SZE-2. A comparison of the TCE plume map for the shallow aquifer (Figure 4-2) with the map of TCE concentrations in surface and shallow subsurface soils (Figure 4-1) shows that the ground water plume configuration was consistent with the locations of soil contamination areas A and B. Figure 4-2 also shows that TCE contamination in the shallow aquifer exceeding the MCL likely extended beyond the boundaries of the facility. The figure also shows that the extent of shallow aquifer plume was not adequately defined because of limited data. Additionally, the center of the shallow aquifer plume with TCE concentrations exceeding 50 percent of TCE solubility was not defined because no data were collected from the southwestern portion of the site. Data were also lacking from the southeastern corner of the site where significant soil contamination was identified (Area C in Figure 4-1).

Intermediate Aquifer Zone. Figure 4-4 shows that TCE concentrations exceeded the MCL of 0.005 mg/L in all of the intermediate aquifer wells sampled in September 1993, except the wells located near the south-central and southwestern boundaries of the facility. The center of the intermediate aquifer plume (with TCE concentrations exceeding 50 percent of its solubility limit) was approximately 100 feet north of the center of the shallow aquifer plume based on a comparison of Figures 4-2 and 4-4. The concentrations near the center of the intermediate aquifer plume (630 mg/L) and the center of the shallow aquifer plume (740 and 650 mg/L) were similar. The extent of the intermediate aquifer plume exceeding the MCL was defined only along the south-central and southwestern portion of the plume; the extent in all other directions was not well-defined. All but two wells (MW-16 and MW-17) were located within or near the boundaries of the Sol Lynn/ITS site. MW-16 and MW-17 showed that TCE contamination exceeding the MCL (0.71 mg/L at MW-16 and 1.5 mg/L at MW-17) had migrated more than 300 feet downgradient of the Sol/Lynn ITS site to the north of highway I-610. The TCE concentration at well MW-7 (51 mg/L) defined a small area of high concentration within the larger plume. This area coincided with soil contamination area C (Figure 4-1). No comparison of the ground water TCE contamination at MW-7 with shallow aquifer data could be made because no shallow wells existed in this area.

Deep Aquifer Zone. Figure 4-5 shows the TCE concentrations in the deep aquifer for September 1993. The TCE concentrations in all the wells sampled exceeded the MCL of 0.005mg/L. Eight wells near the central portion of the facility and one well (MW-21) near the western boundary of the site at Knight Street were sampled. The extent of the deep aquifer TCE plume cannot be defined based on the limited number of sampling points. The center of the deep aquifer plume is consistent with the shallow aquifer plume (Figure 4-2). Whether the main plume and contamination identified near the western boundary (MW-21) were connected is unknown because no data were available within the western portion of the site. The highest detected TCE concentration was 26 mg/L at MW-19.

Three Dimensional Distribution of TCE plumes. A three-dimensional representation of TCE plumes in the surficial aquifer system is presented in Figure 4-6. The figure shows that TCE contamination was widespread within the shallow and intermediate aquifer zones in September 1993. Vertical migration of TCE contamination to the deep aquifer also occurred, as shown in the figure. A more accurate representation of the three-dimensional plumes cannot be generated at this time because of limited data.

4.4.4 TCE Plumes in Ground Water After Three Years of Extraction and Treatment System Operation (November 1996)

Ground water samples were collected from the shallow, intermediate, and deep aquifer zones in November 1996, following three years of ground water extraction and treatment operation that was shutdown on October 14, 1996. During the system operation ground water was extracted from the shallow, intermediate, and deep aquifers and was treated. A portion of the treated ground water was recharged into the shallow and intermediate aquifer starting on October 12, 1994. Some wells in the shallow and intermediate aquifers had been used for both extraction and recharge. Table 4-1 presents the operational history of individual wells operated for the ground water extraction and treatment system. November 1996 sampling was conducted after the system had been shut down for a period of approximately 35 to 40 days (Radian 1997). The ground water samples collected in November 1996 were analyzed for TCE. Figures 4-7, 4-8, and 4-9 are maps of November 1996 TCE concentrations in the shallow, intermediate, and deep aquifers, respectively.

Shallow Aquifer Zone. Figure 4-7 shows the effects of the operation of the extraction and treatment system on the shallow aquifer TCE plume. TCE concentrations may not have reached equilibrium after 35 to 40 days. In November 1996, the lowest TCE concentrations were observed at all the recharge wells (SZR-1, SZR-2, SZER-1 through SZER-5) and monitoring well MW-23B (north of the Sol Lynn/ITS site.) These low concentrations may represent the dilution effects at or near the recharge wells. The concentrations in extraction wells (SZE-2 through SZE-5) were lower than the concentrations observed at these wells before the extraction and treatment system began operation; the concentration in extraction well SZE-1 was higher (506 mg/L in November 1996 compared to 400 mg/L in September 1993.) The extent of the November 1996 shallow aquifer plume exceeding the MCL was not well-defined because of an insufficient number and distribution of wells sampled.

Intermediate Aquifer Zone. The effects of recharging the treated ground water into the intermediate aquifer are apparent in Figure 4-8 which shows the November 1996 TCE concentrations in the intermediate aquifer. TCE was not detected in recharge wells SR-1 and SR-3 through SR-7. The TCE concentration in recharge well SR-2 was 0.002 mg/L. These recharge wells are located along the southern boundary of the Sol Lynn/ITS site. TCE concentrations in extraction wells SE-1 through SE-4 and SE-6) were lower than the baseline concentrations before the extraction and treatment system began operating (Figure 4-4.) The TCE concentration in one extraction well, SE-5, increased from 37 mg/L in September 1993 to 52.5 mg/L in November 1996. Although TCE concentrations in the intermediate aquifer generally were lower in November 1996 than in September 1993, the intermediate aquifer plume does not appear to have shrunk based on a comparison of Figures 4-4 and 4-8. The extent of the November 1996 intermediate aquifer plume exceeding the MCL was well-defined only along the southern and southwestern portion of the plume; the extent in all other directions was not defined. TCE concentrations at downgradient locations in the intermediate aquifer (MW-16 and MW-17) have increased from September 1993 to November 1996. The TCE concentrations at well MW-17 increased from 0.71 mg/L to 4.26 mg/L while the TCE concentration increase in well MW-16 was relatively insignificant (from 1.5 to 1.66 mg/L). These data may indicate the TCE contamination in the intermediate aquifer has migrated and expanded downgradient (northward) from 1993 to 1996.

Deep Aquifer Zone. Figure 4-9 shows the TCE concentrations in the deep aquifer for November 1996; the concentrations were lower in all the wells compared to the concentrations in September 1993 (before the extraction and treatment system began operation.) Between September 1993 and November 1996, the TCE concentrations in the two most contaminated deep aquifer wells decreased from 19 mg/L to 0.0168 mg/L in IE-1 and from 26 mg/L to 0.238 mg/L in MW-19. TCE concentrations remained above the MCL in all the sampling wells except MW-8. The extent of the deep aquifer TCE plume exceeding the MCL was not defined except to the east where TCE was not detected in well MW-8.

Downgradient migration of TCE plumes in the deep aquifer zone is unknown because no wells were installed downgradient of the site. The understanding of the deep aquifer plume distribution is inadequate because of limited data.

4.4.5 TCE Plumes in Ground Water at the End of a Two-Year Shutdown of the Extraction and Treatment System (November 1998)

Ground water samples were collected from the shallow, intermediate, and deep aquifer zones in November 1998, following three years of ground water extraction and treatment system operation and a two-year period of system shutdown. The system was restarted in December 1998. November 1998 ground water samples were analyzed for TCE. Figures 4-10, 4-11, and 4-12 are maps of November 1998 TCE concentrations in the shallow, intermediate and deep aquifers, respectively.

Shallow Aquifer Zone. Figure 4-10 shows the TCE concentrations in the shallow aquifer in November 1998. A comparison of this figure to Figure 4-7, the shallow aquifer TCE concentration map for November 1996 (approximately a month after the system shutdown), showed a rebound effect in ground water TCE concentrations and the plume configuration. The plume spread outward from the center, which is expected after ceasing the operation of the extraction and treatment system. TCE concentrations in most of the recharge wells (away from the plume center) increased. The extent of the shallow aquifer TCE plume (based on concentrations exceeding the MCL) was not defined because all sampling results exceeded the MCL with the exception of the result for well SZE-7; TCE was not detected in that well in November 1998, but the reporting limit for the sample (0.02 mg/L) exceeded the MCL (0.002 mg/L).

Intermediate Aquifer Zone. Figure 4-11 shows the TCE concentrations in the intermediate aquifer in November 1998. A comparison of this figure to Figure 4-8, the intermediate aquifer TCE concentration map for November 1996 (a month after the system shutdown), showed that the plume spread significantly toward the west and southeast. Also, the center of the plume with high TCE concentrations spread to a larger area than that of the plume in November 1996. Newly installed monitoring wells north of highway I-610 provided additional TCE concentration data downgradient (north of the Sol Lynn/ITS site). TCE concentrations in the newly installed wells all exceeded the MCL, except for MW-32 located northeast of the site. The highest detected TCE concentration was 550 mg/L at the newly installed monitoring well MW-27 located north of the site. The TCE plume exceeding the MCL in the intermediate aquifer was not well-defined except along certain portions on the south side where TCE concentrations were below the MCL.

Deep Aquifer Zone. The TCE plume in the deep aquifer zone was not well characterized for November 1998 because of limited data. As shown in Figure 4-12, which is generated based on the limited data points, the TCE concentrations in all the wells sampled exceeded the MCL. The extent of the deep aquifer TCE plume exceeding the MCL was not defined. Locations IE-1 and MW-19, the two wells with the highest previous detections of TCE in the deep aquifer (19 and 26 mg/L, respectively, in September 1993), were not sampled in November 1998.

4.4.6 Current TCE and DCE Plumes in Ground Water (Nine Months After Restarting the Extraction and Treatment System, September 1999)

Ground water samples were collected from the shallow, intermediate, and deep aquifer zones in September 1999, nine months after restarting the ground water extraction and treatment system. During system operation, ground water was extracted from the shallow and intermediate aquifers; the extraction well for the deep aquifer zone (IE-1) and all recharge wells for the shallow and intermediate aquifer zones were not operated during this period. The shallow aquifer zone extraction wells that were operated following the system restart in December 1999 included the extraction wells that were operated during 1993 through 1996 (SZE-1 through SZE-9), the extraction/recharge wells (SZER-1 through SZER-5), and the new extraction wells (SZE-6 through SZE-9). All of the intermediate aquifer extraction wells (SE-1 through SE-6) were operated during this period.

All the shallow and intermediate aquifer extraction wells were not sampled. The system was shut down for repairs for approximately one month before the samples were collected. September 1999 ground water samples were analyzed for TCE, DCE, and vinyl chloride. Only five shallow aquifer monitoring wells were sampled and the data are too few for plume interpretation. No plume contour maps were generated for the shallow aquifer zone.

Figures 4-13 and 4-14 are maps of September 1999 TCE concentrations in the intermediate and deep aquifers, respectively. Figures 4-15 and 4-16 are cis-1,2-DCE maps for September 1999. The ground water samples were also analyzed for vinyl chloride. The vinyl chloride detections are few and are discussed in this section but are not shown on a map.

Shallow Aquifer Zone. No data interpretation is performed for the September 1999 data collected from the shallow aquifer zone because only five monitoring wells were sampled. TCE, cis-1, 2-DCE and vinyl chloride were detected at significant concentrations but the data are too few for plume definition.

Intermediate Aquifer Zone. Figure 4-13 shows the TCE concentrations in the intermediate aquifer for September 1999. A comparison of this figure to Figure 4-11, the intermediate aquifer TCE concentration map for November 1998, shows little change in the TCE plume configuration and TCE concentrations. Notable changes are (1) decreases in TCE concentrations to levels below the MCL in MW-1 and MW-13 near the western boundary of the site and MW-30 (the northernmost well monitored), and (2) decrease in TCE concentration at MW-11 from 340 to 74 mg/L. The current TCE plume exceeding the MCL in the intermediate aquifer is not well-defined except for a portion of the south side of the plume.

Figure 4-15 shows the cis-1,2-DCE concentrations in the intermediate aquifer for September 1999. A comparison of this figure to Figure 4-13, the intermediate aquifer TCE concentration map for September 1999, shows that the cis-1,2-DCE plume exceeding the MCL (0.070 mg/L) covers a similar area as the TCE plume defined by its MCL (0.005 mg/L). The center of the cis-1,2-DCE plume (at well MW-7), however, is southeast of the TCE plume center and coincides with soil contamination area C shown on Figure 4-1. The cis-1,2-DCE plume in the intermediate aquifer exceeding the MCL is not well-defined.

Figure 4-17 shows the vinyl chloride concentrations in the intermediate aquifer for September 1999. The current vinyl chloride plumes are similar to those of the cis-1,2-DCE for the same period. The center of the plume appears to be located at well MW-7. The extent of the vinyl chloride contamination in the intermediate aquifer zone is not well defined because the reporting limits for the analyses of many samples exceeded the MCL. In general, vinyl chloride as a degradation product of TCE and cis-1,2-DCE is widespread in the intermediate aquifer zone at the Sol Lynn/ITS site.

Deep Aquifer Zone. Figure 4-14 shows the TCE concentrations in the deep aquifer for September 1999. The current TCE plume is similar to that of November 1998 (Figure 4-12), but is slightly better defined because a few more wells were sampled in September 1999. The TCE plume exceeding the MCL in the deep aquifer is defined to the south and the northeast only.

Figures 4-16 shows the cis-1,2-DCE concentrations in the deep aquifer for September 1999. Only low concentrations of cis-1,2-DCE were detected in the deep aquifer; none of the concentrations exceed the MCL. Detections below the MCL are within the TCE plume shown on Figure 4-14. Vinyl chloride sampling for September 1999 results in the deep aquifer are all below the reporting limit (0.001mg/L).

4.5 EVALUATION OF THE PRESENCE OF DNAPL

Pure TCE and its degradation products DCE and vinyl chloride are denser than water, and, therefore, often occur as DNAPL, which is capable of migrating downward through porous and fractured media to significant depths within an aquifer system and laterally along the tops of low permeability layers. DNAPL in contact with ground water is a source of dissolved contamination. The spread of DNAPL from the vadose zone into an aquifer system produces sources of dissolved chlorinated solvent ground water contamination that are particularly difficult to locate and remove. Evaluating the presence of DNAPL is important for understanding dissolved contaminant plume distribution and migration and designing an effective remediation program to address chlorinated solvent contamination in ground water.

Small pockets of DNAPL can act as significant sources of dissolved ground water contamination, and are rarely encountered by wells. No direct observation of DNAPL from the Sol Lynn/ITS site wells has been reported. Nevertheless, indirect indications of DNAPL exist and are useful in evaluating the likelihood of DNAPL presence. EPA (1992a) lists conditions that indicate potential for DNAPL based on chemical data including dissolved concentrations of DNAPL-related chemicals in ground water that are greater than one percent of the chemical water solubility. In this section, this DNAPL indicator is applied to evaluate ground water TCE analytical data at the Sol Lynn/ITS site.

The solubility of TCE at 20°C is 1,100 mg/L. The ground water TCE plume maps (Figures 4-2 through 4-13) are contoured with concentration intervals of 11, 110, and 550 mg/L, respectively (equal to 1, 10, and 50 percent of the TCE solubility, respectively). Figures 4-18 through 4-21 present maximum ground water TCE concentrations that are coded with symbols based on these concentration intervals in the shallow aquifer, intermediate aquifer, lower aquitard, and deep aquifer, respectively. The following sections present evaluations of DNAPL presence for the shallow, intermediate, and deep aquifers, as well as lower aquitard. The thickness of the upper aquitard is relatively small and the likelihood for the presence of DNAPL within the upper aquitard is the same as for the shallow and intermediate aquifers.

4.5.1 Shallow Aquifer Zone

Ground water TCE analytical data indicate that DNAPL is probably present in the shallow aquifer. Figure 4-18 shows the maximum TCE concentrations detected in ground water samples from shallow aquifer wells. Maximum ground water TCE concentrations exceed the DNAPL indicator concentration of 11 mg/L (one percent of the TCE solubility) in 16 of 21 shallow aquifer wells. In ten of those wells, the maximum TCE concentration exceeds 110 mg/L (10 percent of the TCE solubility.) The shallow aquifer plume map for September 1993 (Figure 4-2) represents conditions before the ground water extraction and treatment system began operation. In September 1993, TCE concentrations exceeded 11 mg/L over a relatively large portion of the shallow aquifer, covering a minimum area of 50,000 square feet. In November 1998 (following three years of operation of the ground water extraction and treatment system from September 1993 to October 1996 and system shutdown for two years from October 1996 to December 1998), the shallow aquifer TCE plume area containing TCE concentrations above 11 mg/L is still relatively large.

4.5.2 Intermediate Aquifer Zone

Ground water TCE analytical data indicate that DNAPL is probably present in the intermediate aquifer as well as the upper aquitard zone. Figure 4-19 shows the maximum TCE concentrations detected in ground water samples from intermediate aquifer wells. Maximum ground water TCE concentrations exceed the DNAPL indicator concentration of 11 mg/L (one percent of the TCE solubility) in 12 of 30 intermediate aquifer wells. In seven of those wells, the maximum TCE concentration exceeds 110 mg/L (10 percent of the TCE solubility.) The intermediate aquifer plume map for September 1993 (Figure 4-4) represents conditions before the ground water extraction and treatment system began operation. In September 1993, TCE concentrations exceeded 11 mg/L over a relatively large portion of the shallow aquifer, covering a minimum area of 40,000 square feet. In November 1998 (following three years of operation of the extraction and treatment system from September 1993 to October 1996 and system shutdown for two years from October 1996 to December 1998), the intermediate aquifer TCE plume area containing TCE concentrations above 11 mg/L showed no significant change or reduction.

4.5.3 Lower Aquitard Zone

Ground water TCE analytical data indicate that DNAPL may also be present in the lower aquitard (between the intermediate and deep aquifers). Figure 4-20 shows the maximum TCE concentrations detected in ground water samples from three lower aquitard wells. In one of those wells (DS-3) located downgradient of the site (north of highway I-610), the maximum ground water TCE concentration (38 mg/L detected in September 1999) exceeds the DNAPL indicator concentration of 11 mg/L.

4.5.4 Deep Aquifer Zone

Ground water TCE analytical data indicate that DNAPL may also be present in the deep aquifer, but possibly to a lesser extent. Figure 4-21 shows the maximum TCE concentrations detected in ground water samples from deep aquifer wells. In a total of nine deep aquifer wells, the maximum ground water TCE concentrations exceed the DNAPL indicator concentration of 11 mg/L (one percent of the TCE solubility) in two of the wells: IE-1 with a maximum TCE concentration of 19 mg/l and MW-19 with a maximum TCE concentration of 26 mg/L both detected in September 1993. Well IE-1, however, was not monitored after September 1993. A comparison of deep aquifer plume maps for September 1993 through September 1999 (Figures 4-5, 4-9, 4-12, and 4-14) shows a general decrease in TCE concentrations.

4.5.5 Residual Phase DNAPL

Mobile phase or pooled DNAPL were not detected in soil samples collected below the site water table. Undetected masses of residual phase (immobile) DNAPL contamination may exist at some of the shallow aquifer zones near the suspected spill area. Residual phase DNAPL could also exist in the upper aquitard and intermediate aquifer zones. One soil sample collected from the boring for monitoring well MW-4 at 30 to 35 feet bgs (intermediate aquifer zone) contained 2,000 mg/kg of TCE and likely contained some residual DNAPL, that is, TCE product.

The TCE saturation in a soil sample can be calculated using the following equation:

$$S_{TCE} = TCE_{SOIL}\ [\rho_b\ (10^{-6}\ kg/mg)\ /\ (\rho_{TCE})(\phi)] \times 100\%$$

where

S_{TCE}	=	TCE saturation (percent)
TCE_{SOIL}	=	soil TCE concentration (mg/kg)
ϕ	=	total porosity of soil or aquifer matrix (dimensionless)
ρ_b	=	bulk density of soil or aquifer matrix (g/cm)
ρ_{TCE}	=	TCE product density (g/cm)

Assuming a soil total porosity of 0.3, a TCE density of 1.462 g/cm, and bulk density of the aquifer matrix density of 1.7g/cm, the calculated TCE saturation in this sample from MW-4 was approximately 0.8 percent.

4.6 CONTAMINANT TEMPORAL VARIATIONS

Temporal variations in contaminant concentrations at individual wells are important for the characterization of contaminant fate and migration and for evaluation of the ground water remediation system. In this section, ground water TCE contamination temporal distributions (variation trends) at the Sol Lynn/ITS site are evaluated based on the following factors:

- TCE concentrations in different aquifer zones before the start of the ground water extraction and treatment system
- TCE migration in the aquifer system
- Ground water extraction and injection of treated ground water into the shallow and intermediate aquifer zones
- Biodegradation or natural attenuation of the TCE plumes

Temporal trends of TCE degradation products (cis-1,2- DCE and vinyl chloride) are also important but the chemical data for those compounds are insufficient for a temporal trend evaluation. Cis-1,2-DCE and vinyl chloride have been consistently sampled and analyzed only since November 1998.

Figures 4-22 through 4-30 are graphs of TCE concentrations versus time. The figures contain plots for individual wells and show different periods of the ground water extraction and treatment system operation. As shown in Table 4-1, the system operation is divided into four periods: Phase I, Phase II, system shutdown period, and Phase III. Phase I operation was from September 27, 1993 to October 12, 1994. Phase II operation started on October 12, 1994 and ended on October 14, 1996. A two-year system shutdown occurred from October 14, 1996 to December 22, 1998. For the two-year system shutdown, TCE data are only available for the very beginning of the period. The current Phase III operation started on December 1998. The various TCE plume maps (Figures 4-2 through 4-14) show the locations of the wells discussed in this section.

4.6.1 Shallow Aquifer Zone

Figure 4-22 is a graph of ground water TCE concentrations versus time in shallow aquifer monitoring wells FGB-01, MW-25, and MW-26. These monitoring wells were located near the center of the September 1993 ground water TCE plume (before the ground water extraction and treatment system began operation). The TCE concentrations in these wells generally declined during Phases I and II of the ground water extraction and treatment system operation. TCE concentrations in FGB-1 and MW-26 were somewhat lower at the beginning of the two-year shutdown period than at the beginning of Phase III of system operation, and have generally declined during Phase III.

Figure 4-23 is a graph of ground water TCE concentrations versus time in shallow aquifer monitoring well MW-24. This well is the westernmost monitoring well in the shallow aquifer. TCE concentrations in MW-24 have fluctuated with no discernable pattern.

Figure 4-24 is a graph of ground water TCE concentrations versus time in shallow aquifer extraction wells SZE-1 through SZE-5. No declining pattern is identified for these wells. During Phases I and II of the extraction and treatment system operation, TCE concentrations fluctuated in those wells. In extraction wells SZE-2, SZE-4, and SZE-5, the concentrations at the end of the system shutdown period, were the lowest detected since September 1993. The TCE concentrations in extraction wells SZE-1 and SZE 3, however were higher than in some previous samples.

Figure 4-25 is a graph of ground water TCE concentrations versus time in shallow aquifer wells SZER-1 through SZER-5. These wells were operated as extraction wells during Phase I system operation and as recharge wells during Phase II. During Phase I, only one well, SZER-5, showed a declining trend in TCE concentration; no trend could be discerned for the other wells. During Phase II, concentrations were significantly lower than in Phase I, an expected result because of the recharge of treated water in those wells. No data are available to evaluate the trend of TCE concentration changes in these wells after the system restarted in December 1998.

4.6.2 Intermediate Aquifer Zone

Figure 4-26 is a graph of ground water TCE concentrations versus time in intermediate aquifer monitoring wells MW-2, MW-4, MW-5, MW-7, and MW-11. These monitoring wells were located near the relatively higher concentration portions of the September 1993 ground water TCE plume (before the extraction and treatment system began operation). The TCE concentrations have fluctuated erratically and trends cannot be discerned.

Figure 4-27 is a graph of ground water TCE concentrations versus time in intermediate aquifer monitoring wells MW-1, MW-13, MW-15, MW-16, and MW-17. These monitoring wells were located near the relatively lower concentration portions of the September 1993 ground water TCE plume (before the extraction and treatment system began operation). The concentration scale in this graph is logarithmic so that changes in concentrations over several orders of magnitude can be seen. The TCE concentrations have fluctuated erratically and trends cannot be discerned.

Figure 4-28 is a graph of ground water TCE concentrations versus time in intermediate aquifer extraction wells SE-1 through SE-6. During Phases I and II of the system operation, TCE concentrations fluctuated in those wells with no discernable trends, except for SE-4 which displayed a general downward trend. At the end of the system shutdown period, the TCE concentrations in wells SE-3 through SE-6 were the lowest since September 1993.

4.6.3 Deep Aquifer Zone

Figure 4-29 is a graph of ground water TCE concentrations versus time in deep aquifer monitoring wells MW-8, MW-9, MW-10, MW-18, MW-19, MW-20, MW-21, and MW-22. The concentration scale in this graph is logarithmic so that changes in concentrations over several orders of magnitude can be seen. TCE concentrations at the beginning of Phase II of the system operation were significantly lower in all the monitoring wells compared to the concentrations before Phase I began (no data are available for Phase I). By the end of Phase II, most of the monitoring wells showed an increase in TCE concentrations possibly caused by injection of water into the intermediate aquifer zone driving contaminant downward. By the end of the shutdown period, TCE concentrations in most of the wells decreased. No trend is apparent for the TCE concentrations during the Phase III system operation. The most recent TCE concentrations (September 1999) in all the monitoring wells are significantly lower than the concentrations obtained from those wells before system startup in September 1993.

Figure 4-30 is a graph of ground water TCE concentrations versus time in deep aquifer extraction well IE-1. The TCE concentration decreased significantly during Phase I system operation. The TCE concentration had increased by the beginning of Phase II, but then decreased again during Phase II.

4.7 CONTAMINANT FATE AND TRANSPORT MECHANISMS AND PROCESSES

Subsurface contaminant fate and transport are generally controlled by multiple physical, chemical, and biological processes, which can be classified into the three categories shown below:

Physical Processes	Chemical Processes	Biological Processes
Volatilization	Photolysis	Biotransformational
Sorption	Oxidation and reduction	Biodegradation
Advection	Hydrolysis	Bioaccumulation
Dispersion and diffusion	Precipitation and dissolution	
	Dehydrohalogenation	

In addition to these contaminant fate and transport processes listed above, source release mechanisms from primary sources (such as tanks, pipes, drums or solid/liquid waste disposal) or secondary sources (such as contaminated soil, water, or subsurface hydrocarbon products) can also play an important role in contaminant transport. Leaching, desorption, and dissolution are the main mechanisms to contribute subsurface contamination.

The following subsections describe the source release mechanisms and fate and transport processes. A brief discussion of their applicability is also presented.

4.7.1 Source Release Mechanisms

Contaminant releases from the primary sources at the Sol Lynn/ITS site occurred in the past and the mechanisms of the releases are unknown. The primary sources for TCE and PCBs at the site are believed to have been removed. The secondary sources, mainly contaminated soil and ground water, remains to be a concern at the site.

The secondary sources for ground water contamination at the Sol Lynn/ITS site may include the chlorinated solvent products that were originally released from the primary sources and accumulated in the pore spaces of the vadose zone and the shallow aquifer system as DNAPL. In addition, free product can be trapped in the pore spaces as residual product or the chemical compound can be adsorbed on to the vadose zone and aquifer matrix. The source release mechanisms for these secondary sources are dissolution of chemical compounds (leaching) from the free or residual product and desorption of the chemical compounds from the soil and aquifer matrix.

4.7.2 Physical Transport Processes

Volatilization is considered to be significant in the vadose zone and near the water table for the VOCs. Volatilization is generally negligible below the water table or at the lower aquifer zones. Significance of volatilization as a transport process to remove VOC contaminants from subsurface soil and ground water can be tested through soil vapor sample collection and analysis. At the Sol Lynn/ITS site, contaminant volatilization may be limited because the vadose zone soil consists mainly of clay or silt with low permeability and high moisture content even though TCE is readily volatile.

Sorption (also desorption) is an important transport process in the vadose zone and aquifer system. The process applies to all chemical groups (metals and organic compounds) and refers to the physical adsorption of contaminant to soil particles or to particles of organic matter in the soil or aquifer matrix. Significance of the sorption processes can be described using the distribution coefficient (Kd) of chemical compounds. At the Sol Lynn/ITS site, sorption of TCE and other chlorinated solvents to organic matter in the vadose zone soil and the aquifer matrix should be considered. TCE plume migration in the shallow aquifer system is "retarded" by the sorption processes.

Advection is one of the predominant transport processes in ground water. It is the movement of contaminants at the speed of the average linear velocity of ground water. This movement occurs in a vertical downward direction in the vadose zone and in either horizontal or vertical directions (primarily horizontal) in aquifers. At the Sol Lynn/ITS site, two types of advection possibly occurred: (1) free products (DNAPL) advection mainly in the downward direction through fractures in the clay layer, and (2) advection of the dissolved plumes of TCE and other chlorinated solvent compounds following the ground water flow mainly in the horizontal direction within the shallow aquifer system. Advection of suspended particulates (colloid advection) is not considered a significant transport process for TCE contamination at the Sol Lynn/ITS site.

Dispersion is an important transport processes in ground water that is applicable to all chemical groups. Dispersion is often referred to as hydrodynamic dispersion or mechanical mixing in porous media. Dispersion is the tendency for a solute to spread out from the route that it would be expected to follow according to the advective hydraulics of the flow system (Freeze and Cherry 1979). It generally causes dilution and the spreading of contaminant plumes. Hydrodynamic dispersion consists of two components: mechanical dispersion (hereinafter, referred to as dispersion) and molecular diffusion.

Dispersion is caused entirely by the movement of fluid (water). It is the predominant process for the mixing and spreading of contaminants when ground water flow velocity is relatively high. Molecular diffusion, which is caused by the thermal-kinetic energy of contaminant particles, is important only at relatively low flow velocities or in a static system. Molecular diffusion in the aqueous solution of aquifers is rarely a primary factor because mechanical dispersion is generally orders of magnitude more significant. Molecular diffusion can be significant in the aquitards within the shallow aquifer system at the Sol Lynn/ITS site because ground water flow velocity in the two aquitards is believed to be low.

4.7.3 Chemical Fate and Transport Processes

Many chemical processes can occur during contaminant transport through the vadose zone and ground water. The processes include photolysis, oxidation and reduction, hydrolysis, precipitation and dissolution, and dehydrohalogenation. Photolysis is not likely to be significant in subsurface environment because it is chemical decomposition induced by light. Oxidation and reduction refers to chemical reactions through which atoms or molecules lose electrons to another atom or molecule. The result can mean a change in the fate of a particular chemical compound on the surface of the aquifer matrix or moving through the aquifer. Precipitation and dissolution refer to chemical separation or addition to a solution resulting from pH changes in the ground water or soil environment. Dehydrohalogenation refers to the reactions that the halogen elements, usually chlorine or bromine, and hydrogen are removed from the halogenated hydrocarbon compounds.

Generally, the chemical transport processes are difficult to be characterized or quantified in evaluation of contaminant fate and transport. In most cases, chemical transport processes are characterized together as one parameter that represents a total loss rate of contaminants through the processes. Dissolution and precipitation are generally accounted for using water solubility of the chemicals. At the Sol Lynn/ITS site, chemical fate and transport processes are not well understood.

4.7.4 Biological Fate and Transport Processes

Biological fate and transport processes include biotransformation, biodegradation, and bioaccumulation. These processes are very important for the evaluation of fate, pathways, and risks associated with ground water contamination. Biotransformation and biodegradation sometimes refer to the same process in which chemicals are metabolized by microorganisms in soil and ground water. The biodegradation process is believed to be an important fate and transport process for TCE contamination at the Sol Lynn/ITS site. Bioaccumulation, however, is not believed to be of concern because pathways to ecological receptors from ground water contamination are not complete.

Characterization of the biological fate and transport processes are essential to evaluation of natural attenuation. Detailed discussion of the potential for natural attenuation of the TCE ground water plumes at the Sol Lynn/ITS site will be discussed in the following section (section 4.8).

4.8 PRELIMINARY EVALUATION OF NATURAL ATTENUATION IN GROUND WATER

During the supplemental RI/FS, the potential for monitored natural attenuation (MNA) will be assessed as a remedial alternative for ground water contaminated with dissolved TCE and related degradation products. MNA is appropriate as a remedial alternative only when it can be demonstrated to be capable of achieving a site's remedial goals within a time frame that is reasonable compared to that offered by other methods. MNA can be used either alone or in conjunction with active remediation measures (e.g. source control), or as a follow-up to active remediation measures that have already been implemented (Wiedemeier and others 1998).

Natural attenuation in ground water systems results from the integration of several subsurface attenuation mechanisms that are classified as either non-destructive or destructive. Non-destructive attenuation mechanisms, such as sorption, dispersion, dilution, and volatilization, redistribute or transfer rather than destroy the contaminant mass in the subsurface with the result being a decrease in concentrations. Destructive attenuation mechanisms, such as biodegradation and some abiotic processes, actually destroy contaminant mass. Biodegradation is the most important natural attenuation mechanism (Wiedemeier and others 1998).

The key mechanism for the natural biodegradation of the more highly chlorinated solvents such as PCE or TCE in ground water is via a process called reductive dechlorination. During this process carried out by anaerobic microbial organisms, the chlorinated hydrocarbon is used as an electron acceptor, not as a source of carbon, and a chlorine atom is removed and replaced with a hydrogen atom. In general, reductive dechlorination occurs by sequential dechlorination from PCE to TCE to DCE to vinyl chloride to ethene. Reductive dechlorination requires both electron acceptors (chlorinated aliphatic hydrocarbons) and an adequate supply of electron donors. Electron donors include fuel hydrocarbons or other types of anthropogenic carbon (e.g., landfill leachate) or natural organic carbon (Wiedemeier and others 1998).

TCE shows a high potential for biodegradation based on the results of only 14 percent of 85 biodegradation studies (field and laboratory) showing recalcitrance (Suarez and Rifai 1999). Biodegradation of chlorinated solvents in ground water can occur under varying redox and substrate conditions including aerobic, anaerobic and cometabolic (Azadpour-Keeley and others 1999).

4.8.1 Biotic Processes

Biotic processes include aerobic and anaerobic microbial processes as well as cometabolic processes.

In the aerobic pathway, chlorinated compounds are used as electron donors and bacteria use oxygen as a terminal electron acceptor; however, this pathway is likely only active for less oxidized compounds such as vinyl chloride (Bradley and Chapelle 1996). In addition, this pathway is generally only active at the plume margins where dissolved oxygen is more available.

TCE and less chlorinated compounds may also degrade through a cometabolic pathway, where other primary co-substrates such as methane, ammonia, phenol, or toluene are present. Studies have indicated that this biodegradation pathway is limited to low ground water concentrations of TCE due to competitive inhibition and TCE toxicity to microorganisms (Wiedemeier and others 1998; McCarty 1997).

Reductive dechlorination occurs under anaerobic conditions and is considered to be the most important mechanism for chlorinated solvent biodegradation. Through this pathway, chlorine atoms are sequentially removed and replaced with hydrogen. Reductive chlorination of TCE by hydrogenolysis (reductive reaction in which carbon-halogen bond is broken and hydrogen replaces the halogen substitute) produces DCE isomers, which can in turn dechlorinate to vinyl chloride. During reductive dechlorination, all three isomers of DCE can theoretically be produced, however, cis-1,2-DCE is a more common intermediate than trans-1,2-DCE, and 1,1-DCE is the least prevalent of the three DCE isomers when they are present as daughter products. DCE and vinyl chloride, due to their less oxidative state, are less prone to reductive processes and may thus tend to accumulate in ground water under anaerobic conditions.

Literature degradation rates compiled by Suarez and Rifai (1999) indicate that vinyl chloride degrades considerably slower under anaerobic conditions and that reductive dechlorination degradation rates for DCE are approximately 4.5 times less than TCE using first order kinetics (Table 4-2).

4.8.2 Plume Behavior

Wiedemeier and others (1998) classified chlorinated solvent plumes into three types based on the primary substrate source. Individual plumes may exhibit all three types of behavior in different portions of the plume. The three behavior types are:

- Type I Behavior - The primary substrate is an adequate amount of anthropogenic organic carbon such as benzene, toluene, ethylbenzene, and xylene compounds and anaerobic biodegradation of this carbon drives reductive dechlorination. Type I behavior usually results in rapid degradation of TCE.
- Type II Behavior - The primary substrate is an adequate amount of native organic carbon that drives reductive dechlorination. Type II behavior may result in slower degradation.
- Type III Behavior - The supply of native or anthropogenic carbon is inadequate and dissolved oxygen is greater than 1.0 mg/L. TCE will not degrade although vinyl chloride can be rapidly oxidized. Type II behavior may also be caused by the lack of microbes which can degrade chlorinated solvents.

In addition, a combination of the above behaviors can occur which is termed a "mixed behavior" plume. A single plume can exhibit multiple behavior types according to redox conditions and substrate, for example, exhibiting Type I behavior near the source area and Type III behavior downgradient .

4.8.3 Lines of Evidence Used to Evaluate Natural Attenuation

According to U.S. EPA guidance (Weidemeier and others 1998), three lines of evidence can be used to evaluate natural attenuation of chlorinated hydrocarbons at a site, including:

(1) Historical ground water and/or soil chemistry data that demonstrate a clear and meaningful trend of decreasing contaminant mass and/or concentration over time along the flow path of the plume.

(2) Hydrogeologic and geochemical data that can be used to demonstrate indirectly the type(s) of natural attenuation processes active at the site, and the rate at which such processes will reduce contaminant concentrations to required levels. This line of evidence is divided further into two components:

(a) Use of chemical analytical data in mass balance calculations to demonstrate that decreases in contaminant and electron acceptor/donor concentrations can be directly correlated to increases in metabolic end products/daughter compounds.

(b) Using measured concentrations of contaminants and/or biologically recalcitrant tracers in conjunction with aquifer parameters to estimate biodegradation rate constants.

(3) Data from field microcosm studies (conducted in or with contaminated site media) which directly demonstrate the occurrence of a particular natural attenuation process at the site and its ability to degrade the contaminants of concern (typically used to demonstrate biological degradation processes only).

The first line of evidence does not demonstrate that contaminant mass is being destroyed as the reduction in concentrations could be attributed to advection, dispersion, dilution from recharge, sorption and volatilization. In order to demonstrate the destruction of contaminant mass, the second or third lines of evidence need to be used.

Behavior of the solvent plume at the Sol Lynn/ITS site has not been adequately characterized due to the paucity of data. Site characterization data providing evidence of biodegradation include the detection of TCE degradation products including cis-1,2-DCE and vinyl chloride in the shallow and intermediate aquifer zones. Also, a ferric iron reduction zone was suggested by the high total iron results coincident with elevated TCE concentrations in wells completed in the shallow aquifer.

4.8.4 Natural Attenuation Monitoring

Monitoring to evaluate natural attenuation processes is first undertaken as a screening process designed to recognize geochemical environments where reductive dechlorination is possible. The initial screening process would consist of obtaining the following information:

- Chemical and geochemical data presented in Table 4-3 for background and target areas of the plume.
- Locations of source(s) and potential points of exposure and, if subsurface NAPLs are sources, an estimate of the extent of residual and free-phase NAPL.
- An estimate of the direction of ground water flow and contaminant transport velocity.

Collection of geochemical data listed in Table 4-3 would establish baseline concentrations. The concentrations would be assigned weighting factors that are prescribed by U.S. EPA guidance (Wiedemeier and others 1998) that would be used to make a preliminary determination. If, based on the screening criteria, it appears that natural attenuation would be a feasible remedial alternative at the site, additional, more detailed evaluations and data collection may be required.

4.9 SUMMARY OF SITE CONTAMINANT MIGRATION MODEL

The information provided in Sections 4.1 through 4.8 provides the basis for a site contaminant migration conceptual model. A summary of that model is presented in this section.

The nature of primary releases of TCE at the Sol Lynn/ITS are unknown; a review of previous investigation reports did not identify the existence of any documentation of spills or disposal. Based on vadose zone soil analytical results (Figure 4-1), TCE releases were widespread at the Sol Lynn/ITS site. The TCE releases have caused several discrete soil contamination areas as shown in Figure 4-1. Three of these areas (soil contamination areas A, B, and C) are relatively large (between approximately 1,000 and 5,000 square feet). The extent of soil contamination area A is well-defined, but the extents of the other soil contamination areas are not adequately defined.

Chlorinated solvent contamination (TCE and its degradation products, DCE and vinyl chloride) has migrated from the vadose zone soils to the ground water where it has spread laterally and vertically. Figures 4-2 to 4-17 show TCE, cis-1,2-DCE, and vinyl chloride plumes in the different aquifers for different times, but the plumes are not adequately defined. The site has been investigated to depths of approximately 100 feet bgs, and chlorinated solvent contamination exists in ground water at concentrations exceeding MCLs in the shallow, intermediate, and deep aquifer zones. Also, the contamination has migrated through the aquifer system to at least 500 feet downgradient of the site boundary, but the lateral extent of contamination within each of the aquifers, especially downgradient to the north, is not adequately defined. The most widespread data available is for the intermediate aquifer, where TCE contamination covers at least 10 acres, most of which is off site.

The pathways and mechanisms of the chlorinated solvent contamination migration are not well understood. The presence of DNAPL is indicated by the dissolved concentrations and may be widespread; however, DNAPL free product has not been observed in the soil and ground water samples. DNAPL migration through the relatively porous aquifers and the less permeable clay aquitards is likely an important contaminant migration mechanism at this site. The specific mechanism of DNAPL migration through the clay aquitards is not known, but is possibly occurring along fractures in competent clay formations. Another possible mechanism of DNAPL migration downward is through well borings during drilling or along wells that may have been completed improperly.

The shallow aquifer zone is characterized as a thin silty sand layer which is highly heterogeneous. DNAPL product and dissolved plumes can accumulate and spread laterally in this aquifer zone in a complex pattern. The upper aquitard underlying the shallow aquifer zone is relatively thin and may be discontinuous. Therefore, vertical migration of DNAPL product and dissolved plumes through the upper aquitard is inevitable. Currently, DNAPL product in the shallow aquifer and the upper aquitard zone is likely present as a relatively immobile residual phase.

Operation of the extraction and treatment system between September 1993 and November 1996 and from December 1998 until September 1999 affected ground water contaminant migration, but the effects are unclear because of inadequate ground water level and chemical data.

Characterization of biodegradation at the site is minimal. Some evidence of biodegradation exists, however, including (1) the detection of TCE degradation products including cis-1,2-DCE and vinyl chloride in the shallow and intermediate aquifer zones, and (2) a possible ferric iron reduction zone suggested by the high total iron concentrations associated with elevated TCE concentrations in shallow aquifer wells.

4.10 IDENTIFICATION OF DATA GAPS

The site contaminant migration conceptual model contains significant gaps because of insufficient or inadequate data. The principal gaps in the model are as follows:

- Contaminant sources are not adequately characterized.
- The ground water plumes in the shallow, intermediate, and deep aquifers are not adequately defined.
- The pathways and mechanisms of contaminant migration are not well understood, including the role of DNAPL.
- Ground water plume response to extraction and treatment system operation is not adequately characterized.
- Effects of natural attenuation including biodegradation are not known.

Specific requirements to fill the gaps in the model are as follows:

- Collection of additional soil samples to adequately characterize the sources of contamination.
- Evaluation of existing monitoring well configuration and determination of individual well usefulness.
- Installation of additional monitoring wells in the shallow, intermediate, and deep aquifers to adequately define the extent of the ground water contamination and to define the concentration configuration within the plumes.
- Design of a ground water monitoring program that will define the ground water flow regime and contaminant plume configuration under natural ground water flow conditions.
- Collection of chemical data to characterize chemical and biological fate and transport processes so that natural attenuation can be evaluated.
- Detailed file review of the potential offsite sources identified in Section 4.2 to determine whether any offsite sources have potential to impact the site.
- Compilation of information from all available resources regarding the history of TCE usage and possible spillage, leakage, or disposal.

- Development of a three-dimensional contaminant fate and transport model to simulate plume migration and estimate effectiveness of natural attenuation.

5.0 REMEDIAL ALTERNATIVES EVALUATION

This section discusses and evaluates the existing ground water extraction and treatment system. The section also emphasizes the need for source delineation control and removal at the site prior to applying alternate remedial technologies and provides descriptions of alternate remedial technologies that may be considered appropriate for the site in the future.

5.1 EXISTING GROUND WATER EXTRACTION AND TREATMENT SYSTEM

The ground water ROD for the Sol Lynn/ITS site (EPA 1988b) specified ground water extraction and treatment using air stripping followed by recovery of TCE from the stripping tower effluent streams by carbon adsorption. The objective of the ground water treatment system, as stated in the ROD, was to reduce TCE concentrations in site ground water from the approximate 500 mg/L levels detected on the site to 0.005 mg/L over a 10-year period.

The following subsections describe the history and the components of the existing ground water extraction and treatment system at the site and provide an evaluation of the performance of the system based on available data. In addition, a discussion of other potentially applicable remedial alternatives and technologies are discussed in Section 5.5.

5.1.1 System History

Surface and subsurface investigations conducted from 1987 through 1991 at the Sol Lynn/ITS site during the RI/FS and field sampling portions of the remedial design, discovered PCBs in shallow soils and halogenated volatile organics (particularly TCE) in soil and ground water underlying the site. Field sampling, soil and monitoring well borings, and cone penetrometer tests identified three water-producing zones underneath the site contaminated with TCE. The first zone, designated as the "Silty Zone," has been defined as a continuous, water-bearing zone occurring about 20 feet bgs. This technical memorandum has redesignated that zone as the "shallow aquifer."

The second water-bearing zone, previously termed the shallow sand or uppermost aquifer, is the water-bearing zone about 30 to 33 feet bgs. It varies in thickness from 11.6 feet along the eastern edge of the

Sol Lynn/ITS site, to less than 2 feet along the western boundary. This technical memorandum redesignates that zone as the "intermediate aquifer."

The third water-bearing zone was originally designated as the Intermediate Aquifer and is found at a depth of 80 to 90 feet bgs at a fairly constant thickness of 11 feet. A 50-foot-thick clay layer, with the top occurring 38 to 40 feet below the surface, separates the two upper water-bearing sandy zones from the lower water-bearing zone. This technical memorandum redesignates that zone as the "deep aquifer."

Only two zones, the intermediate and deep aquifers, were identified as being contaminated with TCE during the Phase I and II RI conducted by Radian in 1987 and 1988. An off-site environmental assessment conducted adjacent to the site by Groundwater Technology (1990) detected TCE contamination in the shallow aquifer about 20 feet bgs. As addressed in Radian (1993), the remedial action (RA) investigation, conducted in 1992 and 1993, included the shallow silty sand (shallow aquifer) encountered by Groundwater Technology. That investigation resulted in the detection of dissolved TCE concentrations at near saturation levels in the shallow aquifer. In fact, TCE concentrations in the shallow aquifer were found to be significantly higher than concentrations in the underlying intermediate aquifer. In addition, a pumping test indicated that the shallow aquifer was hydraulically connected to the intermediate aquifer.

During the remedial design phase of the project, ground water modeling was used to determine the most appropriate recovery well configuration to capture and remove the TCE plume in the three aquifers. Potential ground water yield was first estimated from pumping tests conducted on the two lower aquifers. These characteristics were then combined with ground water analytical results from the aquifers to design the site ground water extraction and treatment system. Maxim's (1996) report indicates that the shallow and intermediate aquifer model predicted a 9-year clean-up time to achieve the ROD-defined cleanup level of 0.005 mg/L TCE, using a combination of extraction wells and injection wells. The seven extraction wells were designed to pump at a combined total output of 32 gallons per minute (gpm), with 66 percent of the extracted ground water to be reinjected. A cumulative total of 151.4 million gallons of ground water (16.82 million gallons per year) were to be extracted from the shallow and intermediate aquifers. For the deep aquifer, the model predicted an 8-year clean-up time using one extraction well. The well was to extract 3.4 million gallons per year, with about 27 million gallons of ground water to be cumulatively removed and treated.

Subsequent ground water modeling defined a pumping configuration that was to be carried out in an initial two-phased approach, the intent of which was to first remove as much contamination as possible from the shallow aquifer before pumping from the shallow and intermediate aquifers together. The theory behind such an approach was to mitigate the tendency to spread or smear contamination in the fine-grained units separating the two upper water-bearing zones. The approach used during the second phase was to use recharge wells to keep the shallow aquifer saturated, while extracting ground water from all three water bearing zones.

After a 2-year shut down period between 1996 to 1998, a third phase of pumping was initiated. This phase included extracting ground water from the shallow and intermediate aquifers only, with no recharge. These phases and the operation of the system are discussed in more detail in Section 5.1.2 below.

5.1.2 Ground Water Extraction

Components of the ground water extraction system are listed below and shown in Figure 5-1. The original extraction system installation completed in 1993 was later revised and expanded such that more extraction wells were added and some shallow aquifer extraction wells were converted to recharge wells. Table 5-1 provides information on the function of each well and also a summary of the operation schedule of the ground water extraction system.

Shallow Aquifer

***Extraction wells*:**

- A total of 14 extraction wells have been installed in the shallow aquifer.
- 10 extraction wells were originally installed, 6 along the northern property boundary (SZER-1, SZER-2, SZER-3, SZER-4, SZE-3 and SZE-4) and 4 near the center of site (SZER-5, SZE-1, SZE-2 and SZE-5).
- 4 additional extraction wells were added near the center of the site prior to restart of the system in 1998 (SZE-7, SZE-8, SZE-9 and SZE-10).

Injection wells:

- 2 injection wells (SZER-1 and SZER-2) were originally installed along the northeastern property boundary.

- For the period of operation from 1994 to 1996, 5 of the original extraction wells (SZER-1 through SZER-5) were converted to recharge wells.

Intermediate Aquifer

Extraction wells:

- 6 extraction wells (SE-1, SE-2, SE-3, SE-4, SE-5 and SE-6) were installed along the northern property boundary.

Injection wells:

- 7 injection wells (SR-, SR-2, SR-3, SR-4, SR-5, SR-6 and SR-7) were installed along the southern property boundary.

Deep Aquifer

Extraction wells:

- 1 extraction well (IE-1) was installed near the center of the site.

Injection wells:

- No injection wells are installed in the deep aquifer.

Operational phases of the ground water extraction and treatment system are summarized below and in Table 5-1.

Phase I - September 27, 1993 to October 12, 1994:

- Extraction occurred from the 10 original shallow aquifer extraction wells.
- Extraction occurred from the deep aquifer well.
- No extraction wells in the intermediate aquifer were operational.
- No recharge wells were operational.

Phase II - October 12, 1994 to October 14, 1996:

- Extraction occurred from 5 shallow aquifer extraction wells.
- Injection occurred in 7 shallow aquifer recharge wells, 5 of which were converted to recharge wells from extraction wells.
- Extraction occurred from 6 intermediate aquifer extraction wells.
- Injection occurred in 7 intermediate aquifer recharge wells.
- Extraction occurred from the deep aquifer extraction well.

Shutdown II - October 14, 1996 to December 22, 1998

Phase III - December 22, 1998 to Present:

- Extraction occurred from 14 shallow aquifer extraction wells.
- Extraction occurred from 6 intermediate aquifer extraction wells.
- The extraction well in the deep aquifer was not operated.
- No recharge wells were operational.

5.1.3 Ground Water Treatment

The ground water treatment system consists of iron filtration and air stripping followed by liquid phase carbon adsorption and polishing filtration (Radian 2000). Figure 5-2 is a plan view of the remediation system. A schematic process flow diagram of the treatment system is presented in Figure 5-3.

The ground water treatment plant uses air stripping for phase separation of chlorinated solvents from the ground water, with the stripping tower aqueous and vapor effluents being routed through dual stage activated carbon adsorption systems. The air stripping tower is a packed column, designated for countercurrent flow and equipped with a stainless steel wire mesh mist eliminator. Granular activated bituminous carbon is being used for volatile organic compound removal in the aqueous-phase carbon adsorption units. Coconut shell activated carbon is being used for VOC removal in the vapor-phase carbon adsorption units.

Pretreatment for particulates, pH, iron, and manganese are addressed in the ground water treatment system. Using an injection of 16% hydrochloric acid, pH is adjusted to prevent precipitation of metal salts in downstream unit operations. Iron and manganese are removed in a filtration system prior to pH adjustment. This allows metals entering the system to pass through the system as dissolved solids, which are discharged with the aqueous effluent (Maxim 1996).

The ground water treatment system is discussed in more detail in Section 5.3.

5.2 EXISTING GROUND WATER EXTRACTION SYSTEM PERFORMANCE EVALUATION

Contaminated ground water has been extracted and treated through operation of the ground water extraction and treatment system since 1993, and operations have been conducted in three phases. This section addresses the hydraulic effects of the ground water extraction system and the resulting distribution of TCE due to pumping during the three phases.

The original ground water remediation system was designed using ground water flow modeling to remediate the intermediate and deep aquifers. In investigations conducted by Radian in 1992 and 1993, the shallow aquifer was also investigated and TCE concentrations were found to be higher than those in the underlying intermediate aquifer. Based on findings related to the shallow aquifer, the ground water recovery system was subsequently modified using ground water flow modeling to address contamination in the shallow aquifer. The Phase II pumping and recharge configuration design was based directly on the modeling results (Radian 1994).

Ground water elevation data obtained just prior to the initiation of pumping and during the pumping phases was collected during ground water sampling events. The baseline sampling report (SWL 1993) provided the last static ground water level measurements prior to system startup. Ground water levels measured during operational phases of the system were collected prior to sampling events either while the system was operating or after the system had been shut down for several days. For example, data collected on May 26, 1994, was 3 days after the beginning of a sampling event when the system presumably may have been shut down. Ground water elevations collected on November 10, 1995 were during pumping and just prior to a sampling event.

Phase I

The Phase I extraction well configuration consisted of pumping water from the shallow aquifer only, in order to remove as much contamination from the shallow aquifer as possible prior to the initiation of pumping in the intermediate aquifer. It was assumed that pumping in the intermediate aquifer would draw down and potentially dewater the shallow aquifer due to the hydraulic connection between the two aquifers, so the intent of Phase I was to remove as much contaminated ground water as possible prior to pumping the intermediate aquifer, but without lowering water levels in the shallow aquifer to promote subsidence.

Ground water elevation data collected during pumping in Phase I were not available. Ground water elevation data collected on May 26, 1994, was several days after the beginning of a ground water sampling round, presumably after the ground water extraction system had been shut down. Ground water elevations were measured in monitoring and extraction wells. Ground water elevation contour maps prepared from the data and presented in Radian (1995), suggest that the ground water flow patterns had returned to near static conditions in all three aquifers.

Phase II

Recharge wells were added in Phase II in the shallow and intermediate aquifers. The recharge wells in the shallow aquifer were expected to limit dewatering which could result in surface subsidence. The recharge wells in the intermediate aquifer were placed to increase the rate of flow through the intermediate aquifer as well as sustain water levels, and to prevent ground subsidence.

Potentiometric surface elevation data from monitoring, extraction and recharge wells, collected on November 10, 1995 during Phase II operation, are used to generate ground water contour maps (Figures 5-4 through 5-6). The extraction and recharge wells are color coded to show which wells were operational.

Ground water elevation contours in the shallow aquifer (Figure 5-4) show steep, localized effects, including cones of depression associated with extraction wells and mounding associated with recharge wells. Assuming average potentiometric surface elevations of 37 to 38 feet in the shallow aquifer, mounding in recharge wells was from 2 to 7 feet above normal levels and drawdown in extraction wells was approximately 8 to 10 feet. Mounding appears to have been more extreme in the eastern portion of the site in the vicinity of wells SZER-1 and SZER-2, which are furthest from any extraction wells. The contours indicate localized flow gradients and suggest possible hydraulic control in the vicinity of the wells, but the total extent of the capture zone and exact flow lines are difficult to assess with the limited number of monitoring wells in the shallow aquifer.

The intermediate aquifer capture zone on the same date is more apparent in Figure 5-5, in which contour lines were drawn using more data points. The contour lines suggest that recharge wells along the southern edge of the property raise the potentiometric surface several feet, increasing the hydraulic gradient in the direction of an apparent ground water trough, created by drawdown in the extraction wells along the northern perimeter of the site. In the deep aquifer (Figure 5-6), the potentiometric surface contours suggest that the extraction well IE-1 was achieving capture within a radius of at least 120 feet.

The results of ground water sampling conducted in November 1996 (Section 4.4.4) indicate that TCE concentrations in the shallow aquifer decreased at the extraction wells, suggesting that a less concentrated portion of the plume was being drawn into the wells. Injection of clean ground water in the recharge wells appears to have diluted the plume in the vicinity of the wells. However, the plume may have also been driven horizontally and vertically by the steep localized flow gradients created in the shallow aquifer.

In the intermediate aquifer, the ground water sampling results indicate that TCE concentrations decreased in the extraction wells since pumping began. Between September 1993 and November 1996, TCE levels in the deep aquifer decreased in two locations, but measured concentrations were above the MCL in all but one location.

System Shutdown

The extraction and treatment system at the Sol Lynn/ITS site was shut down between October 1996 and December 1998 because of leaking extraction piping. Ground water elevation data was collected in November 1998 at the end of the shutdown and just prior to system start up. The contoured ground water elevations in the shallow aquifer do not appear to be representative of static conditions and may contain anomalous readings.

Ground water sampling results from November 1998 (Section 4.4.5) indicate that TCE levels increased in the shallow aquifer due to a rebound effect after system shut down, however the extent of the plume was inadequately defined due to limited monitoring locations. In the intermediate aquifer, the plume apparently spread significantly to the west and southeast, and was more widely distributed than in November 1996. Samples from deep aquifer monitoring wells indicated that TCE levels exceeded the MCL in all locations.

Phase III

Phase III of the extraction and treatment system was initiated on December 22, 1998 and is currently in operation. Ground water is being extracted from 14 shallow aquifer extraction wells, and 6 intermediate aquifer extraction wells. No recharge wells are operational, and the deep aquifer extraction well (IE-1) is also not operational (Radian 2000).

Ground water levels measured on September 13, 1999 (Figures 5-7 through 5-9), show the effects of the pumping, but data collected in that sampling round was from monitoring wells only. Potentiometric surface contour lines in the shallow aquifer (Figure 5-7) indicate a zone of depressed ground water about 4 to 5 feet lower than normal levels. This zone may tend to dewater the shallow aquifer in a localized area. Ground water flow paths inferred from the contour lines suggest a linear capture zone roughly perpendicular to ground water flow in the central portion of the site.

In the intermediate aquifer (Figure 5-8), contour lines also suggest a depression in the potentiometric surface caused by the extraction wells. Water levels in the aquifer at the lowest point are approximately 7 feet below normal. Ground water flow in the deep aquifer (Figure 5-9) appears to be at nearly static conditions, which would be expected since the deep aquifer pumping well would not have been operational for 3 years.

Ground water sampling results from September 1999 (Section 4.4.6) are inconclusive due to limited sampling locations, although additional chlorinated hydrocarbon analytes (DCE and vinyl chloride) were added to the parameters tested.

Analytical results from the intermediate aquifer indicate that the TCE plume configuration has not changed from those measured after the shutdown period in November 1998, although concentrations have dropped at several monitoring well locations. The cis-1,2-DCE plume in the intermediate aquifer is not well defined, but it appears to be similarly distributed to the TCE plume, suggesting the possibility of biodegradation throughout the plume area. The extent of Vinyl chloride in the intermediate aquifer is not well defined.

In the deep aquifer, the TCE plume is similar to that measured in November 1998. Low concentrations of cis-1,2-DCE were also detected.

5.3 GROUND WATER TREATMENT SYSTEM PERFORMANCE EVALUATION

An evaluation was conducted to review available data pertaining to the operation and efficiency of the ground water treatment plant (GWTP) at the Sol Lynn/ITS site. The objective of the evaluation discussed in the following section was to determine whether the ground water treatment system has been effective at removing TCE from the ground water since initiating operations in September 1993.

This evaluation also attempts to determine if the current system is still an appropriate means of addressing ground water contaminated with TCE in light of newer technologies that have been developed since the ROD was prepared. Information provided to conduct this evaluation includes: (1) the Operations and Maintenance manual for the ground water treatment system (Clearwater Systems); (2) the November 1995 Sol Lynn/ITS Site Status Report (Radian 1990); (3) the November 1996 Sol Lynn/ITS Site Status Report (Radian 1997); (4) the December 1999 Site Status Reports (Radian 2000); (5) the February 1995 Sol Lynn/ITS Remedial Action Interim Report (Radian 1995); and (6) the March 1996 Ground water Extraction and Treatment Performance Evaluation (MAXIM 1996).

5.3.1 Ground Water Treatment Plant

The GWTP is the final phase of the extraction and treatment ground water remediation system. Ground water extracted from the site is treated by the GWTP to remove iron, TCE and other chlorinated solvents, and suspended solids before it is discharged to the sanitary sewer or reinjected into the subsurface using recharge wells. The GWTP, shown in Figures 5-2 and 5-3, consists of an interconnected system of skid-mounted, fully automated, treatment processes. Three primary process units are responsible for removal of most contaminants from ground water entering the GWTP. These processes are the dissolved iron removal unit (LF101A and LF101B), the air stripper column (AS-100), and the dual, in-phase granular activated carbon (GAC) units for both the liquid (LF-100) and vapor phases (VF-100). Overall GWTP capacity is rated by the manufacturer at 85,200 gallons per day (gpd), or about 60 gallons per minute (gpm). Destruction of volatile constituents occurs when the GAC vendor (CETCO) recharges spent GAC by thermally treating the units.

5.3.2 Ground Water Treatment Plant Processes

As ground water is extracted from the aquifers at the site, it is allowed to accumulate in a 10,000 gallon untreated water equalization tank (T-100). The level of water in this tank governs operation of the WWTP while it is in the automatic mode. Normal operation in the automatic mode occurs when the tank contains between 2,100 and 4,400 gallons. When the tank volume drops to less than 2,000 gallons, all transfer processes within the plant shut down until the level rises above that volume.

Water from tank T-100 is pumped by the untreated water transfer pumps (P-100A and P-100B) to the two iron filter tanks (LF-101A and LF-101B) to remove dissolved iron that would otherwise foul the air stripper packing with iron precipitate. The iron is removed with the aid of a proprietary filter media listed in the operation and maintenance (O&M) manual as pyrolox. Each 30-inch diameter, 60-inch high vessel contains 12 cubic feet of the pyrolox media. The iron filters are backwashed every 23.5 hours into a cone-bottomed tank that allows the iron precipitate to settle out for later removal.

As the iron-free water leaves the iron removal system, it passes through an in-line flowmeter and flow totalizer (FT-100) to account for both the current flow and the total volume treated. A 16-percent solution of hydrochloric acid is then injected into the wastewater stream to lower the pH below 7. This prevents precipitation of mineral salts in the air stripper tower packing. The acid is mixed with the wastewater stream as both pass through an in-line static mixer before entering the air stripper column. Water is then piped from the static mixer to the air stripper column (AS-100) where most (theoretical maximum of 95 percent) of the volatile organic contaminants are stripped from the water column. The air stripper column consists of a fiberglass reinforced plastic tank, 15 feet high by 36 inches in diameter, filled with polypropylene media. The water enters the top of the stripper column and percolates over the media inside. Air is forced through the column from underneath to strip the volatile constituents from the wastewater as it percolates over the media. The VOC-laden air then exits the top of the column, where it is piped to an electric vent gas heater. The heater raises the offgas temperature by 40 °F to prevent condensation in the VPCA vessels. The air column pressure is then boosted by 0.5 pounds per square inch to push the air through a mechanical water separator, then through one of the two VPCA units before being vented to the atmosphere. Each VPCA unit contains 60 cubic feet of coconut shell carbon. Sampling ports are located on the piping upstream (SP-101) and downstream (SP-103) of the VPCA units, to allow for determination of contaminant breakthrough from either vessel. Actions taken during plant startup to address leaks in the ductwork connecting the carbon beds eliminated the option of choosing which vessel would be the primary VPCA unit via duct dampers.

Water that percolated through the air stripper collects in the air stripper sump and is then, as the cumulative water level allows, pumped by one of two 60 gpm transfer pumps (P101A and P101B) to the two inline aqueous phase activated carbon adsorption (APCA) tanks. Each tank is 54 inches in diameter by 60 inches tall and contains 80 cubic feet of activated carbon. The tanks are piped so that either tank can act as the primary filter, with the other operating as a polishing unit. Two sampling ports (SP-106 and SP-107) are located in the piping so that breakthrough of contaminants from the primary tank can be determined. Breakthrough is defined in the O&M manual as any liquid sample exceeding the MCL for TCE of 0.005 mg/L. If the sample collected from SP-106, located between the two carbon filters, exceeds the breakthrough limit, the O&M calls for a recommendation to change out the carbon in the primary filter. If the sample collected from SP-107, located downstream of both carbon filters, exceeds 0.005 mg/L, the plant is shut down for determination of appropriate actions. After flowing through both carbon units, the treated water collects in a 10,000-gallon treated water storage tank (T-102) prior to injection into the shallow aquifer or to surface discharge. Float switches in tank T-102 actuate one of two, 60-gpm treated water transfer pumps that move the water through a series of two 0.45 micron filters to remove any remaining suspended solids prior to injection into the shallow aquifer or to surface discharge.

The overall design of the GWTP is efficient, with fully automatic operations available to minimize operator man-hours and potential GWTP upsets due to operator error. All key components are redundant to minimize down-time caused by repair or replacement activities, and the operation of the redundant mechanical units is automatically alternated through programmable logic controllers to ensure even wear on each unit.

5.3.3 Ground Water Treatment Plant Analysis

Three sets of annual data for the operating period from 1993 to 1999 were reviewed to determine the treatment efficiency of the GWTP. Data used to analyze the treatment plant's TCE removal capabilities were derived from those three annual reports, which include Radian's 1995 and 1996 Status Reports, and the 1999 monthly status report for December.

5.3.3.1 Carbon Consumption

Insufficient data exist to identify a discernable trend in carbon consumption. Carbon consumption reported in the 1995 Status Report was a cumulative mass that accounted for usage over the years 1993 through 1995. Individual GWTP throughput and average TCE concentrations for the 1995 reporting period were provided, but to be meaningful in defining a trend, each year's carbon consumption would have to be itemized. Thus, only the monthly carbon usage rates as reported in the 1996 and 1999 Status Reports were relevant to trying to define a consumption trend.

As indicated in Table 5-2, a consumption rate of 20 pounds of carbon per pound TCE removed in 1999 was a substantial increase from the 1996 consumption rate of 9 pounds of carbon consumed per pound of TCE removed. Two data points are insufficient to define a statistically relevant trend, however further analysis of the data was conducted to highlight any process anomalies that might explain the increased usage rate. System data for 1995, 1996, and 1999 are provided in Tables 5-3 through 5-5. Annual system throughput was lower in 1999 than the 1996 period by just over one million gallons, but the average TCE concentration in the ground water entering the GWTP for treatment was similar in 1999 at

56.7 mg/L compared with the 1996 average at 54.6 mg/L. Empirical explanation of the increased consumption rate is further clouded by an almost identical gross TCE mass removal reported in 1996 at 1,172 pounds, versus 1,161 pounds reported in 1999. Thus, no process anomalies are evident that would explain the increased usage. Further complicating this issue is the lack of carbon consumption data by phase type. No data exists defining how much carbon was used or replaced in a given year in the VPCA unit versus the APCA unit. Maxim reports that typical carbon removal isotherms for TCE are approximately 9.0 pounds TCE per 100 pounds of carbon for aqueous phase removal, and 14.5 pounds TCE per 100 pounds of carbon for the vapor phase removal. Clearly, at an average removal rate for the months of January through December in 1999 of 5.1 pounds TCE per 100 pounds carbon, the system as a whole is under performing. A summary of Maxim's (1996) recommendations to improve the capacities of the GWTP includes:

- Define the true breakthrough point in the primary APCA. Stress the adsorption system enough to determine true breakthrough for TCE and DCE, then define the operating breakthrough as a percentage of true breakthrough to establish a more conservative breakthrough criteria.
- Consider modifications to the APCA system to allow periodic backwashing.
- Schedule routine inspections for bacterial/algae growth.
- Increase superficial contact times in the APCA units.
- Ensure, possibly through a more aggressive sampling program, that the iron removal unit is effectively controlling the iron concentration to less than 0.5 mg/L.
- Absence of documented TCE excursions in the VPCA system discharge indicates that some quantity of adsorptive capacity remains undepleted at the currently defined breakthrough point of 60 parts per million by volume (ppmv) measured between the two VPCA units, or 30 ppmv measured at the stack. Apply same aforementioned breakthrough criteria to utilize higher percentage of carbon.

5.3.3.2 TCE Phase Removal

Determination of the phase removal efficiency of the stripping tower was not possible due to the lack of relevant data including volumetric flow rate of air to the VPCA units and concentration of TCE in the liquid phase leaving the stripper column. Maxim's (1996) analysis of the column removal efficiency determined that the stripping tower's VOC transfer efficiency operated from 85 to 95 percent. Their conclusion was that the tower and packing material are oversized for operation under existing conditions (500 to 650 cubic feet of air per minute). Operating at only 11 percent of the flooding velocity (engineering rule of thumb is operation between 50 to 75 percent of the flooding velocity) results in reduced VOC transfer efficiency, and increases the likelihood of the channeling or short-circuiting of air through the unit. Recommendations included making a determination whether optimization of the air stripping process is cost effective weighed against transferring a larger percentage of TCE and DCE to the VPCA units rather than the APCA units. Maxim also recommended investigating the effect that the VOC concentration have on the adsorptive capacity of carbon in both the VPCA and APCA units.

A review of available data (1995 and 1999) shown in Table 5-6 for the GWTP regarding TCE removal from the liquid phase indicates that, in all but two cases, the TCE levels in the water sampled between the two APCA units was either at a non-detectable level or at a reporting level below the MCL. In all cases, the TCE concentration in the treated water tank was below the detection limit of 1.0 μg/l. TCE removal in the vapor phase, however, indicates that both vessels were required to reduce the TCE concentration to dischargeable levels (30 ppmv). Maxim (1996) reported that the primary APCA unit achieved only 25 to 50 percent of the theoretical TCE and DCE adsorption capacities; whereas the VPCA units were operating at or above the theoretical adsorption capacities during the tests they conducted from November 1995 through March 1996. Negative DCE removal (DCE in the GWTP effluent stream) was documented during the same testing conducted by Maxim, who speculated that the process anomaly was likely caused by partial replacement of previously adsorbed DCE by TCE on adsorption sites. It is unclear at the time of this report whether DCE discharge limitations have been addressed.

5.3.3.3 Treatment Capacity

GWTP system throughput has declined steadily over the 3-year period for which data are available. Based on the monthly cumulative flow divided by the days in each month, the calculated average treatment rate has declined from 11 gpm in 1995 to 5 gpm in 1999. Both treatment flow rates are well below the manufacturers maximum recommended treatment plant throughput capacity of 60 gpm. However, as indicated in Maxim's 1996 system analysis report, if the flow rate is increased to the maximum specified 60 gpm, the performance of the iron filtration system should be closely monitored.

In fact, at the time of that report, a net increase in iron concentration across the iron filtration system was discovered; indicating that the filter media was likely depleted. Without removal, elevated concentrations of iron or manganese in the carbon units influent can occupy adsorption sites on the carbon media, thereby rendering it useless for TCE removal. This situation could be further exacerbated if the pH of the iron filter influent is not closely monitored.

5.3.4 Conclusions

The GWTP is a suitable design for the task of removing TCE from the ground water at the site. While it is clear that the GWTP is capable of handling supplemental flow from the proposed new wells, insufficient data exist to discern the impact such an action would have. It would be worthwhile at this juncture to determine if any of Maxim's recommendations have been instituted, and if they have been effective at achieving the specified goals.

5.4 SOURCE LOCATION AND REMOVAL

Prior to continuing ground water remediation at the site or during consideration of alternative or additional remedial methods, all of the locations of the original sources of TCE must be delineated and either contained or removed. The source is defined as any material that continuously generates concentrations of contaminants of concern in ground water that exceed maximum contaminant levels.

Although a volume of PCB and TCE contaminated soils were removed from the site, additional TCE source materials may remain in the subsurface, possibly in the form of DNAPL that is pooled or sorbed onto soil particles.

The lateral and vertical extent of the source must be delineated, as well as the source material strength and the chemical composition.

5.5 ADDITIONAL APPLICABLE REMEDIAL ALTERNATIVES AND TECHNOLOGIES

In addition to evaluating the current ground water extraction and treatment remediation system at the Sol Lynn/ITS site, other applicable remedial technologies will be evaluated in the supplemental RI/FS. This section lists and briefly describe those remedial alternatives and technologies that could potentially be implemented at the site. A complete evaluation of applicability of those technologies at the site should be conducted in the FS after further supplemental RI data collection is completed.

5.5.1 Source Control and Removal

Several remedial technologies could be considered in the source area as source control and removal alternatives for DNAPL remediation in the event that further site characterization verifies the presence and location of DNAPLs on the site. These technologies could also be considered for the management of migration in ground water. The following technologies are described below.

Air Sparging

Air sparging for the remediation of DNAPLs involves injecting air other gases directly into the ground water to vaporize and recover the contaminants. Volatile components of the DNAPLs (such as TCE) will vaporize and move upward into the atmosphere or to a vapor extraction system installed in the vadose zone. During air sparging, direct volatilization of the sorbed and trapped contaminants is enhanced in the zones where airflow takes place. Air sparging has been successful in cleaning up dissolved chlorinated solvent plumes in ground water. In these cases, volatilization is the primary remediation mechanism.

Data needs: Geologic characteristics such as permeability (both vertical and horizontal), porosity, and hydraulic conductivity; contaminant type; depth of contamination; delineation of the location of DNAPL; and the heterogeneities in the air permeability of the subsurface media.

Horizontal Trench Sparging

Trench sparging was developed to apply air sparging under less permeable geologic conditions when the depth of contamination is less than 30 feet. This technique is generally applicable where there is a shallow depth to ground water and the formation is fine grained. Trench sparging includes (1) placement of a single or parallel trench(es) perpendicular to the direction of ground water flow; (2) injection of air through lateral or vertical pipes at the bottom of the trench; and (3) extraction of air from lateral pipes in the trench above the water table. The treated ground water leaving the trench will be saturated with dissolved oxygen and nutrients (if added) and can then enhance the degradation of dissolved and residual contaminants downgradient of the trench. If the primary focus of remediation is containment only, this concept can be implemented as a low-cost containment technique with a single downgradient trench. Depending on the need to clean up the site faster, multiple trenches can be implemented.

Data Needs: Depth of contamination and geological characteristics such as permeability, porosity, and hydraulic conductivity.

In-Well Air Sparging

In-well air-sparging is a patented design for in situ remediation of VOCs in ground water as an alternative to extraction and treatment systems. This technology relies on over-pressurized air to circulate and clean water flowing into a well in the packed-off screen. A pressurized air delivery line is placed in the well to deliver a stream of air bubbles into the well. The rising column of bubbles acts as an air-lift pump pushing the combined stream of air/water up the casing while drawing contaminated water in through the extraction screen. As the air bubbles and water move up through the casing, volatile contaminants vaporize and transfer from the dissolved state to that of a free vapor in the air bubbles. A vacuum is applied at the well head to recover the vapors at a point above the packer and the contaminant vapors are drawn off for treatment.

Data Need: Hydrogeologic conditions such as permeability, porosity, hydraulic conductivity, depth of contamination, and contaminant type.

Alcohol or Cosolvent Flushing

Alcohol or cosolvent flushing involves pumping one or more solvents, at concentrations ranging from a 1 to 80 percent, through the DNAPL source zone to remove DNAPL by dissolution and/or mobilization. Alcohols are the most commonly used solvents, although in principal any organic solvent may be used. A typical system consists of arrays of injection and extraction wells arranged to provide an efficient flood of the source zone. Horizontal wells, trenches, or other delivery systems may be used. Either hydraulic control or containment walls may be used to contain the solvent flood. The effluent solution produced at the extraction wells contains water, solvent, and contaminants and must be treated prior to reinjection or disposal. Recycling of solvents would make the process more cost-effective.

Data Needs: Hydraulic conductivity and geological characteristics such as heterogeneities in the aquifer.

Surfactant-Enhanced Aquifer Restoration

Remediation of DNAPL-contaminated sites with surfactants involves injection of a solution of water plus a surfactant into the source zone and removal of the DNAPL through a combination of dissolution and displacement. Surfactant-enhanced remediation is based on two well-established properties of surfactants: (1) their ability to decrease interfacial tension and (2) their ability to increase the solubility of hydrophobic organic compounds. A typical system consists of arrays of injection and extraction wells arranged to provide an efficient flood of the source zone. Horizontal wells, trenches, or other delivery systems may be used. Either hydraulic control or containment walls may be used to contain the solvent flood. The effluent solution produced at the extraction wells contains water, solvent, and contaminants and must be treated prior to reinjection or disposal. Recycling of solvents would make the process more cost-effective.

Data Needs: Hydrogeologic conditions such as permeability, heterogeneities in the aquifer, surfactant type, and contaminant type.

In-Situ Oxidation

In-situ oxidation systems work by injecting an oxidizing compound into the DNAPL source zone. DNAPLs are destroyed through chemical reaction with the oxidizer. The system extracts excess oxidizer (if any) and then flushes water through the treatment zone. Potassium permanganate and hydrogen peroxide have been field tested as oxidizers in these systems. The reaction of potassium permanganate or hydrogen peroxide injected in source zones (with or without ferrous iron as a catalyst) with DNAPLs yields carbon dioxide and water, plus chloride and other byproducts. The extent of reaction and the end products are determined by a combination of the reagents used, the DNAPL components, and time. Potassium permanganate, or any other persistent reagent, will generally have to be washed from the treated zone by water flooding after oxidation is complete. Hydrogen peroxide spontaneously decomposes to water, so extraction of excess oxidant is not required for systems using this reagent.

Data Needs: Contaminant type, selection of oxidant, heterogeneities in the aquifer, soil organic fraction, pH, permeability, and hydraulic conductivity.

Steam Enhanced Extraction

Steam enhanced extraction involves the injection of steam into a contaminated unit to volatilize and mobilize contaminants, including DNAPLs. Condensed steam and contaminants are recovered at extraction wells. The recovered fluids (hot water plus contaminants) must be treated at the surface. A variant of steam injection uses hot water, with the objectives of mobilizing the contaminant through the reduction of viscosity and, in a commercial application termed the Contained Recovery of Oily Wastes process, reducing downward migration through reduction of DNAPL density. Another variant of the process combines steam injection with direct electrical heating of fine-grained units.

Data Needs: Permeability, hydraulic conductivity, heterogeneities in the aquifer, and contaminant type.

Permeable Barriers

A permeable reactive barrier consists of a zone of reactive material, such as granular iron, installed in the path of a dissolved chlorinated solvent plume. As the ground water flows through this permeable barrier, the chlorinated organics come in contact with the reactive medium and are degraded to potentially nontoxic dehalogenated organic compounds and inorganic chloride. The main advantage of this system is that, generally, no pumping or aboveground treatment is required; the barrier acts passively after installation. A permeable barrier may be installed as a continuous reactive barrier or as a funnel-and-gate system. A continuous reactive barrier consists of a reactive cell containing the permeable reactive medium. A funnel-and-gate system has an impermeable section (or funnel) that directs the captured ground water flow towards the permeable section (or gate). At sites where the ground water flow is very heterogeneous, a funnel-and-gate system can allow the reactive cell to be placed in the more permeable portions of the aquifer. At sites where the contaminant distribution is very nonuniform, a funnel-and-gate system can better homogenize the concentrations of contaminants entering the reactive cell. A system with multiple gates can be used to ensure sufficient residence time at sites with a relatively wide plume and high ground water velocity, especially when the size of each reactive cell or gate is limited by the method of emplacement.

Data Needs: Hydrogeologic conditions such as hydraulic conductivity, permeability, contaminant type, depth of contamination, distribution of contaminants, ground water flow system characteristics, organic composition of the ground water, and inorganic composition of the ground water.

Monitored Natural Attenuation

The term monitored natural attenuation, as used in EPA's Office of Solid Waste and Emergency Response Directive 9200.4-17 (EPA 1997), refers to the reliance on natural attenuation processes (within the context of a carefully controlled and monitored site cleanup approach) to achieve site-specific remedial objectives within a time frame that is reasonable compared to that offered by other more active methods. The "natural attenuation processes" that are at work in such a remediation approach include a variety of physical, chemical, or biological processes that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in soil and ground water. These in-situ processes include biodegradation, dispersion, dilution, sorption, volatilization; and chemical or biological stabilization, transformation, or destruction of contaminants.

Data Needs: Hydrogeologic conditions such as ground water flow direction or velocity, electron acceptor and donor concentrations, ground water chemistry, aquifer heterogeneity, microbiological data, and a historical plume database.

In-Situ Bioremediation

In situ bioremediation involves the breakdown of contaminants by biologically mediated metabolic reactions under both aerobic and anaerobic conditions if environmental factors are conducive to microbiological growth. It may involve the addition of an electron acceptor (e.g., oxygen), nutrients, and/or an additional carbon source. Organic contaminants are degraded to carbon dioxide, water, and their component ions during biodegradation.

Although aerobic degradation reactions (in which oxygen acts as the electron acceptor) are highly effective at remediation of some less chlorinated solvents and metabolites of chlorinated solvents, most DNAPL components resist aerobic degradation. Most common DNAPL components, such as PCE and TCE, degrade more readily under anaerobic conditions, primarily by reductive dechlorination. Reductive dechlorination requires some other carbon source to serve as a primary substrate which may be organic carbon naturally occurring in the aquifer, a co-contaminant (petroleum hydrocarbons, for example), or a compound added by injection. This type of enhanced anaerobic biodegradation is most likely to be effective in treating plumes dissolving from pure phase DNAPLs, rather than the DNAPLs themselves.

Data Needs: Ground water composition; ground water microbiological data; hydrogeology such as permeability, thickness, and location of the aquifer; heterogeneous zones in the aquifer; and contaminant type.

Vertical Barriers

Vertical barriers can provide rapid and significant risk reduction by isolating the contaminant source from the flowing ground water. They also can provide opportunities for enhanced remediation by controlling ground water hydraulics and/or allowing chemical treatment of the aquifer that would not be possible without physical containment. Geologic and hydrogeologic conditions must be favorable for emplacement of vertical barriers, including a shallow water table and a low-permeability unit into which the vertical barrier can be keyed.

Data Needs: Aquifer permeability, heterogeneity, the presence of bedrock or large cobbles, the presence of an aquitard, the depth to the bottom of the contaminated zone, and contaminant properties.

Horizontal Barriers

Horizontal barriers are widely used beneath modern municipal, hazardous waste, and DOE landfills. Emplacement of horizontal barriers beneath existing uncontained sources of ground water contamination is likely to become more common. These constructed horizontal barriers are potentially quite useful in addressing DNAPL contamination problem because they can act to minimize downward migration of the contaminants.

Data Needs: Aquifer permeability, heterogeneity, the presence of bedrock or large cobbles, the presence of an aquitard, the depth to the bottom of the contaminated zone, and contaminant properties.

Dual-Phase Vacuum Extraction Technology

Dual-phase vacuum extraction (DVE) technology, which simultaneously removes ground water and soil vapor from the subsurface, has been applied at a DNAPL site with promising results. DVE has been used to enhance ground water recovery to attain a zone of capture by enhancing ground water yields from ground water recovery wells not attainable from pumping alone. Operation of the DVE system has also resulted in the recovery of significant quantities of DNAPL consisting primarily of TCE. Controlled pumping has also been applied to recover free phase TCE.

Data Needs: Depth to ground water, hydraulic conductivity, permeability in the aquifer, contaminant type and distribution, ground water levels and its variation

5.5.2 Ex-Situ Treatment Technologies

The following section discusses technologies that should be considered to treat extracted ground water or extracted vapor generated during in situ or ex situ remedial alternatives for ground water.

Air Stripping

Air stripping is a physical mass transfer process and is generally considered as the best available technology for treating many VOCs present in contaminated ground water. Air stripping uses relatively clean air to remove contaminant VOCs dissolved in water and transfers the contaminants into the gaseous phase. When the level of VOCs discharged from an air stripper exceeds guidelines established by federal, state, or local authorities, it is necessary to provide a control technology to treat the effluent air.

Three basic types of technologies are commonly applied for the treatment of air discharges: vapor-phase activated carbon, thermal oxidation, and biofiltration. Selection of any of the above technologies will depend on the airflow rate, the type of contaminants, and the mass loading.

Data Needs: One important factor that must be considered during design of air strippers is water chemistry. The presence of significant amounts of naturally occurring inorganic compounds such as iron, manganese, or carbonates adversely affects an air stripper's removal efficiency. In addition, due to the oxygen in the air and indigenous bacteria present in the extracted ground water, biological fouling can take place when organic compounds are biodegradable. Furthermore, if the ground water extraction wells are not designed properly, significant amount of suspended solids will be deposited in the air strippers.

Steam Stripping

Steam stripping for ground water treatment is essentially a distillation process where the heavy product is water and the light product is a mixture of volatile organics. The process of steam stripping takes place at high temperatures compared to air stripping, usually very close to the boiling point of water. This process is more suitable for compounds that are very volatile and have a low Henry's law constant due to their high solubility. Because the volatility of the organics is a very strong function of temperature, the high stripping temperatures inherent in steam stripping allow for the removal of more soluble organics that are not strippable by air. Another very important feature of steam stripping is the fact that no offgas treatment is needed and the only waste stream generated is a small amount of concentrated VOCs that needs to processed further.

Data Needs: Ground water chemistry and contaminant type.

Granular Activated Carbon Adsorption

Adsorption with GAC is a treatment technology that is now widely accepted for removal of VOCs from ground water. Adsorption occurs when an organic molecule is brought to the activated carbon surface by diffusion and held there by physical and/or chemical forces. In the GAC process, ground water is pumped through a series of canisters containing activated carbon to which dissolved organic contaminants adsorb. The technology requires periodic replacement or regeneration of saturated carbon.

Data Needs: Ground water chemistry, pretreatment requirements such as removal of metals or suspended solids, bench and pilot-scale studies to design and predict the performance of a full-scale GAC system.

Chemical Oxidation

During chemical oxidation, an organic compound is converted, by means of an oxidizing agent, into end products typically having either a higher oxygen or lower hydrogen content that the original compound. Chemical oxidation process uses ozone and hydrogen peroxide (individually or together) in conjunction with ultraviolet (UV) light to destroy organic contaminants present in ground water. This technique is popular for chlorinated organic compounds that are difficult to be treated by biodegradation.

Data Needs: Nature of contaminant mixture, pH, concentrations of contaminants, presence of scavengers such as bicarbonate and carbonate ions, suspended or colloidal solids, and inorganic foulants.

Catalytic Oxidation

Catalytic oxidation is a conventional type heat exchanger with a catalyst. Catalytic oxidation systems are typically applied to low-concentration VOC streams, since high VOC concentrations and associated high heat contents can generate enough heat of combustion to deactivate the catalyst. Dilution air may be required when the influent VOC concentrations are high.

Data Needs: Influent VOCs concentration and influent stream composition. Influent stream containing lead, arsenic, sulfur, silicone, phosphorus, bismuth, antimony, mercury, iron oxide, tin, zinc, and other catalyst deactivators have a tendency to mask or poison the catalyst's cell structure.

Vapor Phase Granular Activated carbon

Vapor-phase GAC is generally used in a fixed bed, and the contaminated air is passed through the adsorbent bed containing carbon granules. When the carbon has been saturated with contaminants, it is regenerated in place, removed and regenerated at an off-site facility, or disposed.

Data Needs: Influent VOCs concentrations, influent stream composition, and influent air moisture content and relative humidity.

6.0 SUMMARY OF DATA REQUIREMENTS AND RECOMMENDATIONS

This section summarizes the data needs for the supplemental RI/FS and data collection recommendations.

Data Needs from Previous Investigative Activities

- A well inventory and well integrity evaluation (direct or indirect) should be conducted for all wells installed at the site. Poorly constructed wells that could cause vertical migration of contaminant through the well boring should be properly abandoned.
- A site survey should be conducted to confirm all datum for the water level measurements. Review of the existing data indicates possible measurement errors.

Site Hydrogeological Characterization

- Aquifer heterogeneity, especially for the shallow and intermediate aquifer zones, should be further characterized through CPT, other direct push technologies, or borings.
- Lower aquitard should be further characterized to identify whether the 60-foot zone can be characterized as a water-bearing zone.
- Static ground water level data reflecting the natural flow patterns in all three aquifers should be collected and current condition ground water potentiometric maps should be generated.
- Ground water level data under the ground water extraction and treatment system operation conditions should be collected to characterize the capture zone and hydraulic effects of the system operation.
- Aquifer hydraulic tests should be conducted in the shallow, intermediate, and deep aquifer zones to further characterize: (1) aquifer horizontal and vertical hydraulic properties, and (2) interrelationships between the aquifer zones.
- Ground water geochemistry data include basic cation and anion concentrations, aquifer redox potentials, TDS, dissolved oxygen and other geochemical parameters should be collected.
- Ground water recharge to the shallow, intermediate, and deep aquifer zones should be further evaluated. Discharge or ground water usage data should also to be compiled.
- A refined three-dimensional ground water flow model should be developed to further understand the flow pattern under different remediation scenarios and to help characterize contaminant migration.

Site Contaminant Migration Characterization

- Collection of additional soil samples to adequately characterize the sources of contamination.
- Evaluation of the existing monitoring well configuration and determination of individual well usefulness.
- Installation of additional monitoring wells in the shallow, intermediate, and deep aquifers to adequately define the extent of the ground water contamination and to define the concentration configuration within the plumes.
- Design of a ground water monitoring program that will define the ground water flow regime and contaminant plume configuration under natural ground water flow conditions.
- Collection of chemical data to characterize chemical and biological fate and transport processes so that natural attenuation can be evaluated.
- Compilation of information from all available resources regarding the history of TCE usage and possible spillage, leakage, or disposal.
- Development of a three-dimensional contaminant fate and transport model to simulate plume migration and estimate effectiveness of natural attenuation.

Evaluation of Alternative Remediation Technologies

More data are needed to evaluate feasibility of other applicable remediation technologies. Data needs for remedial alternative evaluation are discussed in detail in Section 5.5. Recommendation for data collection will be made to focus on evaluating several of the most applicable remedial alternatives. Specific recommendations may be made during development of the RI/FS work plan and sampling and analysis plan.

7.0 REFERENCES

Azadpour-Keeley, A., H.H. Russell, and G.W. Sewell. 1999. "Microbial Processes Affecting Monitored Natural Attenuation of Contaminants in the Subsurface." U.S. EPA Office of Research and Development, Ground Water Issue, September

Bechtel BWXT Idaho LLC. (undated). Identification of Alternative Remedial Technology Data Needs for the Supplemental Remedial Investigation at the Sol Lynn/Industrial Transformer Superfund Site, Geosciences Dept. Idaho National Engineering and Environmental Laboratory.

Bledsoe, B.E. 1991. "Estimating Aquifer Cleanup Time at the Sol Lynn/Industrial Transformers Superfund Site, Houston, Texas." Technical Assistance Report to EPA Region VI. 59 p.

Bomar, George W. 1983. Texas Weather. University of Texas Press, Austin, Texas, 265 pp.

Bradley, P.M.and F.H. Chapelle. 1996. "Anaerobic Mineralization of Vinyl Chloride in Fe III-Reducing Aquifer Sediments." Environmental Science and Technology, Vol. 30, No. 6, pp. 2084-2086.

Cohen, R.M. and W. Mercer. 1993. *DNAPL Site Evaluation,* CRC Press, Boca Raton, Florida, 384 p.

Environmental Data Resources (EDR). 2000. Water Well Review, Sol Lynn. February 24.

EPA. 1988b. "Record of Decision for Industrial Transformer Site, Phase II." September.

EPA. 1991. Groundwater Remediation Using Pump and Treat Technology; Sol Lynn/Industrial Transformers Superfund Site, Houston, TX, Prepared for EPA Region 6 by the U.S. EPA R.S. Kerr Environmental Research Laboratory, Ada OK. May 2.

EPA. 1992a. Estimating Potential for Occurrence of DNAPL at Superfund Sites. Publication 9355.4-07FS. January.

EPA. 1992b. "Memorandum on Ground Water Remediation at Superfund Sites." May 27.

EPA. 1997. Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action and Underground Storage Tank Sites, U.S. EPA Office of Solid Waste and Emergency Response Directive 9200.4-17.

EPA. 1999. "U.S. Environmental Protection Agency, Statement of Work, Sol Lynn/Industrial Transformer Superfund Site." December 1999.

Fisher, W.L. 1982. "Geologic Atlas of Texas, Houston Sheet, Scale: 1:250,000." Bureau of Economic Geology.

Fisher, W.L., McGowen, J.H. Brown, L.F., Jr. and Groat, C.G. 1972. Environmental Geologic Atlas of the Texas Coastal Zone, Houston-Galveston Area, Bureau of Economic Geology, University of Texas at Austin, Austin TX.

Freeze, R.A and J.A. Cherry. 1979. “Groundwater,” Prentice-Hall, Inc.

Groundwater Technology. 1990. Initial Site Assessment, First Gilbralter Bank. FSB Property, 1400 South Loop West, Houston Texas.

Haitjema, H.M. 1995. “Analytic Element Modeling of Groundwater Flow.” The GFLOW Model.

Hamlin.H.S., Smith D.A. and Akhter M.S. 1988. “Hydrogeology of Barbers Hill Salt Dome, Texas Coastal Plain.” Bureau of Economic Geologh. Report of Investigations No. 176

Kreitler, C.W. 1976. Lineations and Faults in the Texas Coastal Zone, Report of Investigations No. 85, Bureau of Economic Geology, University of Texas at Austin, Austin TX.

Lavigne, Deborah. 1990. Accurate, On-site Analysis of PCBs in Soil, A Low Cost Approach, Dexsil Corporation, Hamden, Connectticut

MAXIM Technologies Inc. (Maxim). 1996. “Groundwater Extraction and Treatment Performance Evaluation of the Industrial Transformer Superfund Site.” Texas Natural Resource Conservation Commission.

McCarty, P.L. 1997. “Aerobic Cometabolism of Chlorinated Aliphatic Hydrocarbons.” In: C.H. Ward, J.A. Cherry, and M.R. Scalf (Eds.) Subsurface Restoration, pp. 373-395. Ann Arbor Press, Inc., Chelsea, Michigan.

Pankow, James F., and Cherry, John A. 1996. *Dense Chlorinated Solvents and other DNAPLs in Groundwater*, 1996, Waterloo Press.

Radian Corporation. 1988a. Final Site Investigation Report, Industrial Transformer Superfund Site Prepared for Texas Water Commission (TNRCC). May.

Radian. 1988b. Radian Corporation, Final Investigation Report, Phase II, Groundwater Contamination, Prepared for Texas Water Commission (TNRCC), December.

Radian. 1988c. Radian International, Final Feasibility Study, Phase II Groundwater Contamination. Prepared for Texas Water Commission (TNRCC). December.

Radian. 1991. “Industrial Transformer Superfund Site Groundwater Modeling Report.” Prepared for Texas Water Commission, Division of Superfund and Emergency Response. July.

Radian. 1992. “Industrial Transformers Superfund Site Ground Water Remediation Design, Technical Specifications, Final Design Package.”

Radian. 1993. “Silty Zone Investigation Report, Industrial Transformer Superfund Site, Houston, Texas.” January.

Radian. 1994. "MODFLOW Model Report Industrial Transformer Superfund Site." April.

Radian. 1995. “Industrial Transformer Superfund Site Annual Model Evaluation Operation Year, 27 September 1993 to 14 November 1994.” February.

Radian. 1996. "Annual Model Evaluation Operation Year, 15 November 1994 to 10 November 1995, Final Report." March.

Radian. 1997. “Remedial Action Oversight Contract, November 1996 Status Report.” March.

Radian. 2000. “Technical Memorandum, Industrial Transformer Superfund Site, Remedial Action Oversight Contract, December 1999 Status.” January.

Suarez, M.P. and H.S. Rifai. 1999. “Biodegradation Rates for Fuel Hydrocarbons and Chlorinated Solvents in Groundwater.” In Publication. 17 p.

Southwestern Laboratories, Inc. 1993. Baseline Groundwater Sampling Report, Industrial Transformer Superfund site, Houston, Texas. Prepared for Texas Natural Resource Conservation Commission. October.

Texas Department of Water Resources. 1979. “Stratigraphic and Hydrogeologic Framework of Part of the Coastal Plain of Texas.” Report 236.

U.S. Department of Agriculture (USDA). 1976. “Soil Survey of Harris County, Texas.” Prepared by the Natural Resources Conservation Services, USDA. Washington, D.C.

U.S. Geological Survey (USGS). 1978. “Computer Model of Two-Dimensional Solute Transport and Dispersion in Ground Water.” USGS MOC model. Authored by L.F. Konikow and J.D. Bredehoeft.

USGS. 1993. “Modular Three-Dimensional Finite-Difference Ground Water Flow Model.” 93/08/30. Authored by M.G. McDonald and A.W. Harbaugh.

Wiedemeier, T.H., Swanson, M.A., Moutoux, D.E., Gordon, E.K., Wilson, J.T., Wilson, B.H., Kampbell, D.H., Hass, P.E., Miller, R.N., Hansen, J.E., and Chapelle, F.H. 1998. Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater, EPA/600/R-98/128, Office of Research and Development, U.S. Environmental Protection Agency, Washington, DC. September.

TABLES

TABLE 1-1

CHRONOLOGY OF SITE ACTIVITIES AND EVENTS

Date	Site Activity or Event
1965 to 1975	ITS is the site of the unincorporated, Industrial Transformer Company, owned and operated by Mr. Sol Lynn.
September 11, 1972	The State of Texas brings suit against Mr. Sol Lynn, on charges of illegally discharging industrial waste into Brays Bayou.
1975 to 1981	Sila-King, Inc., a chemical supply company operates at 1419 South Loop West, a portion of the site.
November 10, 1978	A TNRCC inspection showed no signs of oil spills or unauthorized discharges.
January 13, 1980	A TNRCC representative observes old drums and an oily discharge from a drum storage area behind Sila-King, Inc.
September 11, 1981	Analytical results of samples collected by the City of Houston indicate that the soil and ground water at the site were contaminated with trichloroethylene.
November 14, 1981	A City of Houston work crew notes strong chemical odors while installing a waterline adjacent to the property. The TNRCC and the City of Houston Department of Health inspect the area and find about 75 drums, labeled TCE, scattered across the property. Most of the drums were empty and punctured.
March 18 to 29, 1982	Drums observed previously (November 1981) disappear from the site.
February 29, 1984	The Solid Waste Enforcement Unit of the TWC request that EPA rank the ITS site for corrective action in the Superfund program.
October 5, 1984	EPA ranks the site for corrective action through the Superfund program.
June 30, 1986	Radian executes a Remedial Investigation/Feasibility Study contract.
October 13, 1986	Radian completes the Quality Assurance Project Plan, Remedial Investigation and Feasibility Study for the TNRCC.
January 14, 1987	As part of the remedial investigation, Radian initiated field work at the site. The remedial investigation identifies the presence of TCE in the soils, in shallow saturated sand (approximately 35 feet below ground surface), and in intermediate saturated sand (approximately 80 feet below ground surface).
January 1988	Radian completes the Quality Assurance and Quality Control Report for the TNRCC.

TABLE 1-1 (Continued)

CHRONOLOGY OF SITE ACTIVITIES AND EVENTS

Date	Site Activity or Event
May 1988	Radian completes a Final Feasibility Study-Surficial Soil Contamination report for the TNRCC. Based on the remedial investigation and feasibility study, EPA issued a Record of Decision specifying pump-and-treat as the appropriate remedial method.
May 1988	Radian completes the Final Site Investigation Report for the TNRCC. Radian has collected water, soil, and sediment samples to identify the lateral and vertical extent, concentration level, and volume of contaminants.
September 23, 1988	EPA Region 6 signs a Ground Water record of decision implementing air stripping as the remedy.
December 1988	Radian completes the Final Feasibility Study, Phase II, Ground Water Contamination report.
August 29, 1990	Radian completes the Quality Assurance Project Plan, Phase II, Remedial Design Sampling for TWC.
August 1990	Radian completes the Health and Safety Project Plan, Remedial Design Sampling for TWC.
August 1990	Radian completes the Site Management Plan for TWC.
November 27, 1990	Radian completes the Site Sampling Plan Phase II Remedial Design for TWC and EPA.
May 2, 1991	EPA completes the Estimating Aquifer Cleanup Time at the Sol Lynn ITS Site report.
November 1991	Radian submits a final design package to TNRCC and EPA.
July 24, 1992	TNRCC sends correspondence from Mary E. Dunn to James O. Lofstrom, LMNCO, Inc. regarding request for access.
September 30, 1992	EPA amends the Source Control record of decision implementing the final remedy for excavation and off-site disposal of PCB- and TCE-contaminated soil.
November 1992	SWL completes the Site Management Plan for TNRCC.
December 1992	SWL completes the Drilling and Well Installation Procedures for TNRCC.
January 1993	Radian completes the Silty Zone Investigation Report finding that the zone (1) contained high concentrations of dissolved TCE, and (2) was hydraulically connected to the shallow sand occurring at a depth of 30 to 40 feet.
October 8, 1993	Radian begins Phase I of the Treatment Phase. Radian extracted ground water from all 10 of the Silty Zone extraction wells and from the Intermediate Aquifer extraction well, with no recharge of treated water.
October 1993	SWL completes the Baseline Ground Water Sampling Report for TNRCC.

TABLE 1-1 (Continued)

CHRONOLOGY OF SITE ACTIVITIES AND EVENTS

Date	Site Activity or Event
October 12, 1994	Radian authorizes the initiation of Phase II of the Treatment Phase. This phase included (1) extracting ground water from the Shallow Sand, Silty Zone, and Intermediate Aquifer wells; (2) treating the water and recharging into the subsurface via Silty Zone and Shallow Sand Aquifer recharge wells; and (3) surface discharging any treated water not recharged into the aquifers.
April 1994	Radian completes the Modflow Model Report for TNRCC. The final proposed remedial system consisted of placing 12 wells in the 20-foot depth zone, and 13 wells in the 35-foot depth zone.
February 23, 1995	Huntington Engineering & Environmental completes the Operation and Maintenance Manual.
February 1995	Radian completes the AITS Remedial Action Interim Report for TNRCC.
May 1995	Maxim Technologies, Inc. completes the Ground Water Extraction and Treatment Performance Evaluation for TNRCC.
March 1996	Radian completes the Annual Model Evaluation, Operation Year 15 November 1994 to 10 November 1995 for TNRCC.
May 1996	Radian completes the Remedial Action Oversight Contract Lost Well Report-Final for TNRCC.
February 23, 1998	Texas Department of Transportation sends correspondence from Jose A. Garza to John R. Kovski, Radian, regarding work on I-610 Superfund Site.
June 1, 1998	Radian completes the First Draft Feasibility Study, Phase II Ground Water Contamination for TNRCC.
August 3, 1998	WRS completes the Contractor Quality Control Plan.
August 3, 1998	WRS completes the Environmental Protection Plan.
August 3, 1998	WRS completes the Site Security Plan.
August 3, 1998	WRS completes the Spill Control Plan.
August 3, 1998	WRS completes the Temporary Controls Plan.
September 17, 1998	Radian completes the Draft Final QAPP Phase 2: Remedial Design Sampling, Revision 2 for TNRCC.
December 1998	WRS completes the Record Drawing.
January 15, 1999	Radian completes the Deep-Shallow Aquifer Baseline TCE Concentration Contours.
January 15, 1999	Radian completes the Intermediate Aquifer Baseline TCE Concentration Contours.
January 15, 1999	Radian completes the Shallow Aquifer Baseline TCE Concentration Contours.
January 15, 1999	Radian completes the Silty Aquifer Baseline TCE Concentration Contours.

TABLE 1-1 (Continued)

CHRONOLOGY OF SITE ACTIVITIES AND EVENTS

Date	Site Activity or Event
March 1999	Radian completes the Health and Safety Project Plan, Remedial Design Sampling for TNRCC.
May 11, 1999	Radian completes the Well Identification Map.
December 2, 1999	EPA completes the Statement of Work for a Supplemental Remedial Investigation/Feasibility Study.

Notes:

EPA	U.S. Environmental Protection Agency
ITS	Industrial Transformer Company site
PCB	Polychlorinated biphenyl
Radian	Radian Corporation
SWL	Southwestern Laboratories, Inc.
TCE	Trichloroethene
TNRCC	Texas natural Resources Conservation Commission
TWC	Texas Water Commission
WRS	WRS Infrastructure & Environment

TABLE 3-1

REGIONAL STRATIGRAPHIC AND HYDROGEOLOGIC UNITS IN THE HOUSTON AREA

System	Series	Stratigraphic Unit	Hydrogeologic Unit	Isopach Range (feet)	Net Sand (feet)
Quaternary Period	Holocene Epoch Pleistocene Epoch	Alluvium Beaumont Formation	Upper Chicot aquifer	200 to 400	30 to 200
Tertiary Period	Pliocene Epoch	Lissie Formation	Lower Chicot aquifer	30 to 300	30 to 300
	Miocene Epoch	Willis Formation Goliad Formation	Evangeline aquifer	30 to 1,800	0 to 950
		Lagarto Formation	Burkeville aquitard	300 to 500	0 to 150

Source: Fisher 1988.

TABLE 3-2

COMPARISON OF NOMENCLATURE OF HYDROSTRATIGRAPHIC UNITS

<table>
<tr><th>Approximate Depth</th><th>Generalized Lithology</th><th>Previous Unit (Radian 1988)</th><th colspan="2">Previous Unit (Radian 1994)</th><th>Previous Unit (Radian 2000)</th><th>Revised Unit (TtEMI 2000)</th></tr>
<tr><td>0 to 18 feet</td><td>Clay</td><td>NA</td><td colspan="2">NA</td><td>–</td><td>Vadose zone and confining clays</td></tr>
<tr><td>18 to 23 feet</td><td>Silty sand</td><td>NA</td><td>Silty zone</td><td rowspan="3">Upper aquifer</td><td>20-foot zone</td><td>Shallow aquifer</td></tr>
<tr><td>23 to 33 feet</td><td>Clay</td><td>NA</td><td>–</td><td>–</td><td>Upper aquitard</td></tr>
<tr><td>33 to 40 feet</td><td>Sand and silty</td><td>Uppermost</td><td>Upper sand</td><td>40-foot zone</td><td>Intermediate aquitard</td></tr>
<tr><td>40 to 80 feet</td><td>Clay with sandy silt lenses</td><td>NA</td><td colspan="2">NA</td><td>60-foot zone</td><td>Lower aquitard</td></tr>
<tr><td>80 to 90 feet</td><td>Sand</td><td>Intermediate aquifer</td><td colspan="2">Intermediate sand</td><td>80-foot zone</td><td>Deep aquitard</td></tr>
</table>

Note:

NA Nomenclature not available

TABLE 3-3

AQUIFER HYDRAULIC PARAMETERS

Hydraulic Conductivity (K)		Hydraulic Gradient (i)	Storativity (S)	Seepage Velocity (V)
SHALLOW AQUIFER				
28.4 gpd/ft^2	3.79 ft/day	0.00265	0.0001	10.5 ft/year
INTERMEDIATE AQUIFER				
191 gpd/ft^2	25.5 ft/day	0.0034	0.0001	106 ft/year
DEEP AQUIFER				
3.74 gpd/ft^2	0.5 ft/day	0.0083	0.0001	–

Source: Radian, 1993 & 1994

TABLE 3-4

WATER WELLS LOCATED WITHIN 2 MILES OF THE SITE

Owner's Name	Source	Well Number	Depth of Well (feet)	Date Drilled	Well Use
Anton Wanek	Harris County	65-30-101	108	Prior to 1971	Not reported
G.G. Pyburn	Harris County	65-29-208	230	Prior to 1971	Not reported
Herman Hospital	Harris County	65-21-307	417	Prior to 1971	Not reported
Harris County Flood Control	Harris County	65-21-620	214	Prior to 1971	Not reported
Texaco	Harris County	65-21-619	285	Prior to 1971	Not reported
W.F. Curlee Manufacturing Co.	Harris County	65-21-911	235	Prior to 1971	Not reported
Zero Food Co.	Harris County	65-22-412	89	Prior to 1971	Not reported
St. Paul United Ch. of Christ	Harris County	65-22-710	293	Prior to 1971	Not reported
Edgewood Little League Park	Harris County	65-22-811	106	Prior to 1971	Not reported
Miller Trucking	EDR 2000	65-21-6	232	1985	Domestic
Linbeck Construction	EDR 2000	65-21-6B	453	1980	Domestic
Thermal Energy Corp.	EDR 2000	65-21-6C	702	1984	Public supply
Cement Lining Co.	EDR 2000	65-21-6E	75	1973	Industrial
Smothers	EDR 2000	65-21-6F	68	1974	Domestic
C. Wong	EDR 2000	65-21-6F	190	1980	Domestic
Martin Oil and Gas	EDR 2000	65-21-6J	236	1975	Domestic
T.K. James Co.	EDR 2000	65-21-6M	85	1979	Supply/industrial
T.K. James Co.	EDR 2000	65-21-6M	83	1979	Supply/industrial
Fogel Equipment Co.	EDR 2000	65-21-6N	530	1980	Domestic
Onyre Energy Corp.	EDR 2000	65-21-6P	470	1983	Domestic
Texas Gulf Sulfer Co.	EDR 2000	65-21-9a	247	1965	Supply/industrial
Mrs. M. T. Stevenson	EDR 2000	65-21-9A	241	1975	Domestic
Texas Gulf Sulfer Co.	EDR 2000	65-21-9G	202	1965	Supply/industrial
Texas Gulf Sulfer Co.	EDR 2000	65-21-9C	286	1965	Supply/industrial
Cement Lining Co.	EDR 2000	65-21-9V	76	1979	Industrial
Astroworld	EDR 2000	65-21-6	324	1992	Other
Star Tex Oil Co.	EDR 2000	65-21-6B	292	1966	Domestic
Signal Oil Co.	EDR 2000	65-21-6C	290	1966	Domestic
Wanda Petroleum Co.	EDR 2000	65-216J	772	1977	Industrial

TABLE 3-4 (Continued)

WATER WELLS LOCATED WITHIN 2 MILES OF THE SITE

Owner's Name	Source	Well Number	Depth of Well (feet)	Date Drilled	Well Use
Charles W. Patronella	EDR 2000	65-21-6K	321	1975	Domestic
Metal Arts	EDR 2000	65-21-6L	337	1978	Industrial
Blackbroiler	EDR 2000	65-21-6M	332	1985	Domestic
Exxon Corporation	Radian 1988	3429	77	1979	Not reported
Dresser Magcobar-Alameda	Radian 1988	3429	542	1979	Not reported
International Tool & Supply	Radian 1988	3174	542	1956	Not reported
International Tool & Supply	Radian 1988	2787	468	1962	Not reported
International Tool & Supply	Radian 1988	2786	Not reported	1981	Not reported
International Tool & Supply	Radian 1988	3928	Not reported	1981	Not reported
Southwestern Bell Telephone	Radian 1988	3223	Not reported	1968	Not reported
Texaco	Radian 1988	2807	289	1967	Not reported
Exxon Company	Radian 1988	2992	Not reported	Not reported	Not reported
Harris County	Radian 1988	3298	150	1966	Not reported
Institute Place	Radian 1988	LJ-65-21-605	310	1928	Not reported
Magcobar Mud Co.	Radian 1988	LJ-65-21-610	320	1946	Not reported
Magcobar Mud Co.	Radian 1988	LJ-65-21-611	542	1956	Not reported
Metal Arts Co.	Radian 1988	LJ-65-21-614	468	1962	Not reported
Metal Arts Co.	Radian 1988	LJ-65-21-615	540	1966	Not reported
Huston Gulf Gas Co.	Radian 1988	LJ-65-21-618	211	1929	Not reported
Harris County Flood Control	Radian 1988	LJ-65-21-620	432	1960	Not reported
International Tools	Radian 1988	LJ-65-21-624	337	1978	Not reported

TABLE 4-1

CONFIGURATION OF GROUNDWATER EXTRACTION AND TREATMENT SYSTEM

<table>
<tr><th rowspan="2">Well ID</th><th colspan="4">WELL FUNCTION</th></tr>
<tr><th>Operation Phase I
(9/27/93 to 10/12/94)</th><th>Operation Phase II
(10/12/94 to 10/14/96)</th><th>System Shutdown
(10/14/96 to 12/22/98)</th><th>Operation Phase III
(12/22/98 to present)</th></tr>
<tr><td colspan="5">SHALLOW AQUIFER EXTRACTION WELL</td></tr>
<tr><td>SZE-1</td><td colspan="2" rowspan="5">Extraction</td><td rowspan="5">Not Operated</td><td rowspan="9">Extraction</td></tr>
<tr><td>SZE-2</td></tr>
<tr><td>SZE-3</td></tr>
<tr><td>SZE-4</td></tr>
<tr><td>SZE-5</td></tr>
<tr><td>SZE-6</td><td colspan="3" rowspan="4">Not Operated</td></tr>
<tr><td>SZE-7</td></tr>
<tr><td>SZE-8</td></tr>
<tr><td>SZE-9</td></tr>
<tr><td colspan="5">SHALLOW AQUIFER EXTRACTION/RECHARGE WELL</td></tr>
<tr><td>SZER-1</td><td rowspan="5">Extraction</td><td rowspan="5">Recharge</td><td rowspan="5">Not Operated</td><td rowspan="5">Extraction</td></tr>
<tr><td>SZER-2</td></tr>
<tr><td>SZER-3</td></tr>
<tr><td>SZER-4</td></tr>
<tr><td>SZER-5</td></tr>
<tr><td colspan="5">SHALLOW AQUIFER RECHARGE WELL</td></tr>
<tr><td>SZR-1</td><td rowspan="2">Not Operated</td><td rowspan="2">Recharge</td><td colspan="2" rowspan="2">Not Operated</td></tr>
<tr><td>SZR-2</td></tr>
<tr><td colspan="5">INTERMEDIATE AQUIFER EXTRACTION WELL</td></tr>
<tr><td>SE-1</td><td rowspan="6">Not Operated</td><td rowspan="6">Extraction</td><td rowspan="6">Not Operated</td><td rowspan="6">Extraction</td></tr>
<tr><td>SE-2</td></tr>
<tr><td>SE-3</td></tr>
<tr><td>SE-4</td></tr>
<tr><td>SE-5</td></tr>
<tr><td>SE-6</td></tr>
</table>

TABLE 4-1 (Continued)

CONFIGURATION OF GROUND WATER EXTRACTION AND TREATMENT SYSTEM

Well ID	WELL FUNCTION			
	Operation Phase I (9/27/93 to 10/12/94)	Operation Phase II (10/12/94 to 10/14/96)	System Shutdown (10/14/96 to 12/22/98)	Operation Phase III (12/22/98 to present)
INTERMEDIATE AQUIFER EXTRACTION WELL				
SR-1	Not Operated	Recharge	Not Operated	
SR-2				
SR-3				
SR-4				
SR-5				
SR-6				
SR-7				
DEEP AQUIFER EXTRACTION WELL				
IE-1	Extraction		Not Operated	

TABLE 4-2

FIRST ORDER BIODEGRADATION RATES (DAY^{-1}) OF TRICHLOROETHENE, DICHLOROETHENE, AND VINYL CHLORIDE UNDER VARYING REDOX CONDITIONS

Parameter	All Studies	Overall Aerobic	Overall Anaerobic Reductive Dechlorination	Reductive Dechlorination Field/In Situ Studies	Reductive Dechlorination Laboratory
TCE					
Number of rates	86	29	56	32	24
Mean	0.173	0.346	0.086	0.003	0.196
Standard deviation	0.475	0.517	0.434	0.005	0.654
90th Percentile	0.636	1.354	0.022	0.006	0.337
Reported ranges	0-3.130	0-1.650	0-3.130	0-0.023	0-3.130
DCE all isomers (not including cis-1,2-DCE)					
Number of Rates	27	–	19	16	3
Mean	0.149	–	0.019	0.003	0.101
Standard deviation	0.302	–	0.061	0.001	0.147
90th Percentile	0.666	–	0.012	0.005	0.220
Reported ranges	0-1.150	–	0.001-0.270	0.001-0.006	0.010-0.270
Vinyl Chloride					
Number of rates	26	4	8	4	4
Mean	0.229	0.087	0.153	0.003	0.303
Standard deviation	0.476	–	0.228	–	–
90th Percentile	0.946	–	0.499	–	–
Reported ranges	0-1.960	0.043-0.125	0-0.520	0-0.007	0-0.520

Notes:
DCE Dichloroethene
TCE Trichloroethene
Half-life can be calculated using $t_{1/2} = \ln 2/\lambda$, where λ is the first order biodegradation rate constant

Source: Modified from Suarez and Rifai (1999)

TABLE 4-3

SUMMARY OF GROUND WATER MONITORING REQUIREMENTS PROPOSED FOR NATURAL ATTENUATION PROTOCOLS

Requirement	Parameter
Field parameters	pH Temperature Specific conductivity Dissolved oxygen Oxidation reduction potential
Primary substrate	Dissolved organic carbon TCE DCE Vinyl chloride
Redox indicators	Ferrous Iron Sulfate Sulfide Methane
Geochemical indicators	Alkalinity Nitrate
Biodegradation end products	Chloride Ethene Ethane
Optional analyses	Dissolved hydrogen biologically available iron III

Notes:

DCE Dichloroethene
TCE Trichloroethene

TABLE 5-1

GROUND WATER EXTRACTION SYSTEM OPERATION SCHEDULE

Well ID	30-day period beginning on July 16,1993	September 27, 1993 to October 12, 1994	October 12, 1994 to October 14, 1996	October 14, 1996 to December 22, 1998	December 22, 1998 to Present
SHALLOW AQUIFER					
SZE-1	system test	extraction	extraction	shutdown	extraction
SZE-2	system test	extraction	extraction	shutdown	extraction
SZE-3	system test	extraction	extraction	shutdown	extraction
SZE-4	system test	extraction	extraction	shutdown	extraction
SZE-5	system test	extraction	extraction	shutdown	extraction
SZE-6	–	–	–	–	extraction
SZE-7	–	–	–	–	extraction
SZE-8	–	–	–	–	extraction
SZE-9	–	–	–	–	extraction
SZER-1	system test	extraction	injection	shutdown	extraction
SZER-2	system test	extraction	injection	shutdown	extraction
SZER-3	system test	extraction	injection	shutdown	extraction
SZER-4	system test	extraction	injection	shutdown	extraction
SZER-5	system test	extraction	injection	shutdown	extraction
SZR-1	–	–	injection	shutdown	–
SZR-2	–	–	injection	shutdown	–
INTERMEDIATE AQUIFER					
SE-1	–	–	extraction	shutdown	extraction
SE-2	–	–	extraction	shutdown	extraction
SE-3	–	–	extraction	shutdown	extraction
SE-4	–	–	extraction	shutdown	extraction
SE-5	–	–	extraction	shutdown	extraction
SE-6	–	–	extraction	shutdown	extraction
SR-1	–	–	injection	shutdown	–
SR-2	–	–	injection	shutdown	–
SR-3	–	–	injection	shutdown	–
SR-4	–	–	injection	shutdown	–
SR-5	–	–	injection	shutdown	–
SR-6	–	–	injection	shutdown	–
SR-7	–	–	injection	shutdown	–
DEEP AQUIFER					
IE-1	system test	extraction	extraction	shutdown	shutdown

TABLE 5-2

CARBON CONSUMPTION ANALYSIS

Year(s)	Treatment System Production (gallons)	TCE Removed (pounds)	Carbon Replaced (pounds)	Carbon per TCE Replaced	Pounds of TCE Removed per 10,000 Gallons Water Treated
1993 to 1995	9,244,070	3,630	44,400	12	3.93
1996	3,488,885	1,172	12,000	9	3.36
1997	No data	No data	No data	No data	No data
1998	No data	No data	No data	No data	No data
1999	2,443,385	1,161	22,800	20	4.75

Note:

TCE = trichloroethene

TABLE 5-3

TCE REMOVAL IN 1995

Month	Treatment System Throughput (gallons)	TCE Concentration (μg/L)	TCE Removed (pounds)
January	580,146	68,000	230.9
February	376,204	55,800	129.9
March	389,674	47,750	148.3
April	235,764	43,000	102.0
May	487,532	46,000	192.9
June	467,910	55,000	177.9
July	621,515	47,667	220.4
August	676,325	44,333	197.5
September	543,745	42,250	188.6
October	534,840	34,200	168.7
November	405,134	41,675	127.6

Notes:

TCE Trichloroethene

μg/L Micrograms per liter

TABLE 5-4

TCE REMOVAL IN 1996

Month	Treatment System Throughput (gallons)	TCE Concentration (μg/L)	TCE Removed (pounds)
January	648,435	34,920	185.7
February	360,305	33,350	98.8
March	420,285	41,725	143.6
April	532,628	34,500	154.0
May	280,452	38,433	93.1
June	396,510	43,450	143.9
July	634,170	41,520	220.5
August	114,128	43,900	41.8
September	38,744	126,000	33.8
October	63,228	108,000	57.0
November	0	No Sample	0

Notes:

TCE Trichloroethene

μg/L Micrograms per liter

TABLE 5-5

TCE REMOVAL IN 1999

Month	Treatment System Thoughput (gallons)	TCE Concentration (μg/L)	TCE Removed (pounds)
January	183,638	85,000	130
February	265,177	72,000	159
March	239,970	59,000	118
April	226,069	53,000	101
May	216,231	66,000	119
June	270,152	59,000	133
July	234,903	57,000	112
August	208,760	52,000	91
September	186,471	45,000	70
October	164,914	42,000	58
November	247,100	34,000	70

Notes:

TCE Trichloroethene

μg/L Micrograms per liter

TABLE 5-6

TCE CONCENTRATIONS IN TREATMENT SYSTEM

Date	TCE Influent Concentration (μg/L)	TCE Concentration Between Beds (μg/L)	Treated Tank TCE Concentration (μg/L)
November 1, 1995	34,100	ND	ND
November 8, 1995	34,400	2	ND
November 15, 1995	No Sample	-	-
November 22, 1995	45,800	2.71	ND
November 29, 1995	43,900	6.43	ND
December 30, 1998	73,000	20	ND
January 21, 1999	97,000	ND	ND
January 28, 1999	97,000	ND	ND
February 3, 1999	88,000	ND	ND
February 9, 1999	72,000	ND	ND
February 17, 1999	86,000	ND	ND
March 4, 1999	60,000	ND	ND
March 12, 1999	56,000	ND	ND
March 17, 1999	60,000	ND	ND
March 29, 1999	51,000	ND	ND
April 5, 1999	93,000	ND	ND
April 12, 1999	15,000	ND	ND
April 19, 1999	54,000	1.3	ND
April 26, 1999	84,000	1.3	ND
May 3, 1999	62,000	ND	ND
May 12, 1999	63,000	ND	ND
May 17, 1999	55,000	ND	ND
May 24, 1999	44,000	ND	ND
June 3, 1999	55,000	ND	ND
June 7, 1999	74,000	ND	ND
June 14, 1999	63,000	ND	ND
June 21, 1999	59,000	ND	ND
June 28, 1999	58,000	ND	ND
July 6, 1999	57,000	1.3	0.51
July 12, 1999	51,000	1.3	ND
July 19, 1999	60,000	ND	ND
July 26, 1999	59,000	ND	ND
August 2, 1999	50,000	ND	ND
August 9, 1999	53,000	ND	ND
August 16, 1999	54,000	ND	ND

TABLE 5-6 (Continued)

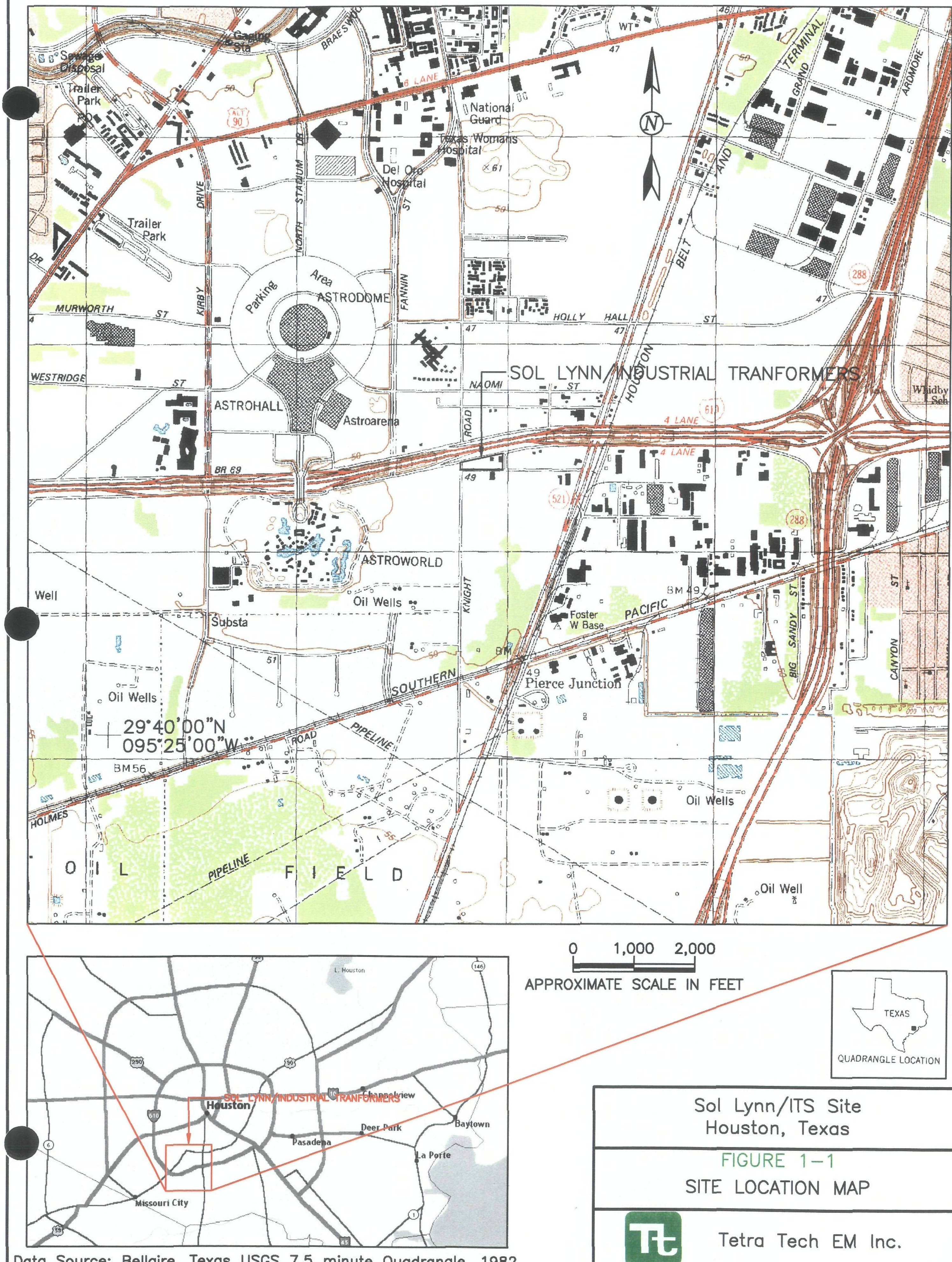
TCE CONCENTRATIONS IN TREATMENT SYSTEM

Date	TCE Influent Concentration (μg/L)	TCE Concentration Between Beds (μg/L)	Treated Tank TCE Concentration (μg/L)
September 27, 1999	49,000	0.52	ND
October 4, 1999	46,000	ND	ND
October 11, 1999	41,000	0.57	0.56
October 18, 1999	43,000	ND	ND
October 25, 1999	34,000	ND	ND
November 1, 1999	31,000	ND	ND
November 8, 1999	30,000	ND	ND
November 15, 1999	74,000	ND	ND
November 22, 1999	35,000	ND	ND
November 29, 1999	34,000	ND	ND
December 6, 1999	33,000	ND	ND
December 13, 1999	31,000	ND	ND
December 20, 1999	36,000	ND	ND
December 27, 1999	37,000	3,100	1.3

Notes:

μg/L Micrograms per liter
ND Not detected
TCE Trichloroethene

FIGURES

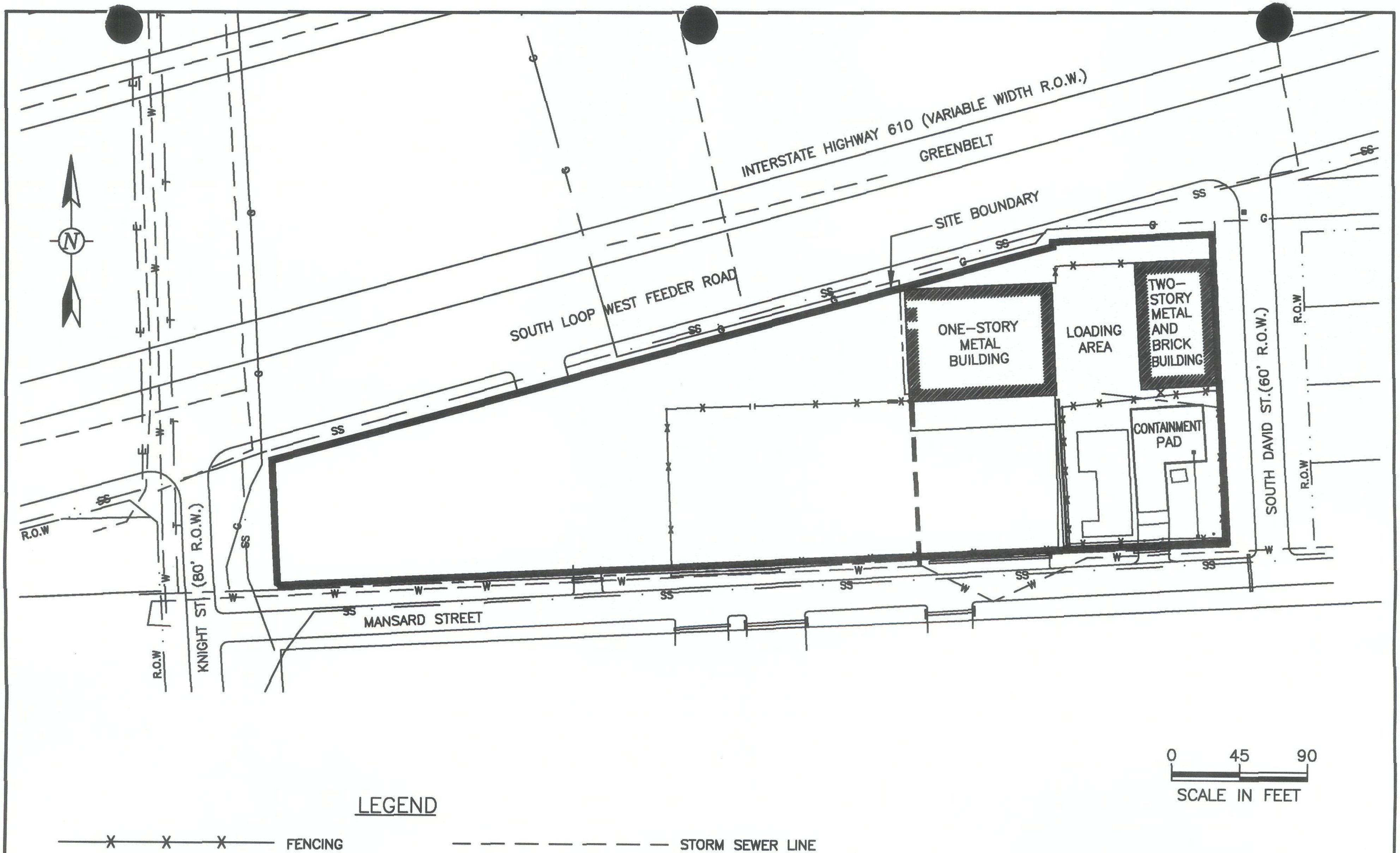


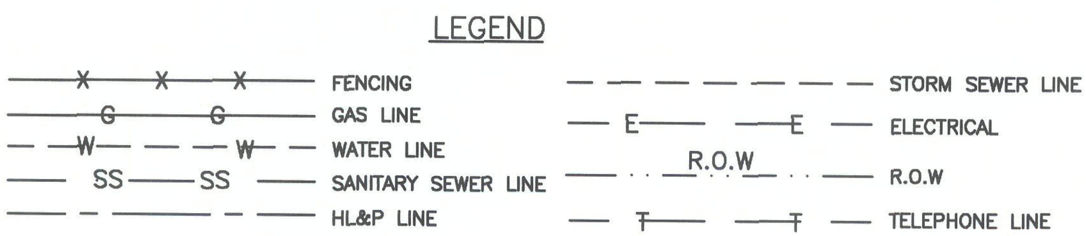
Data Source: Bellaire, Texas USGS 7.5 minute Quadrangle, 1982.

Sol Lynn/ITS Site
Houston, Texas

FIGURE 1-1
SITE LOCATION MAP

Tetra Tech EM Inc.



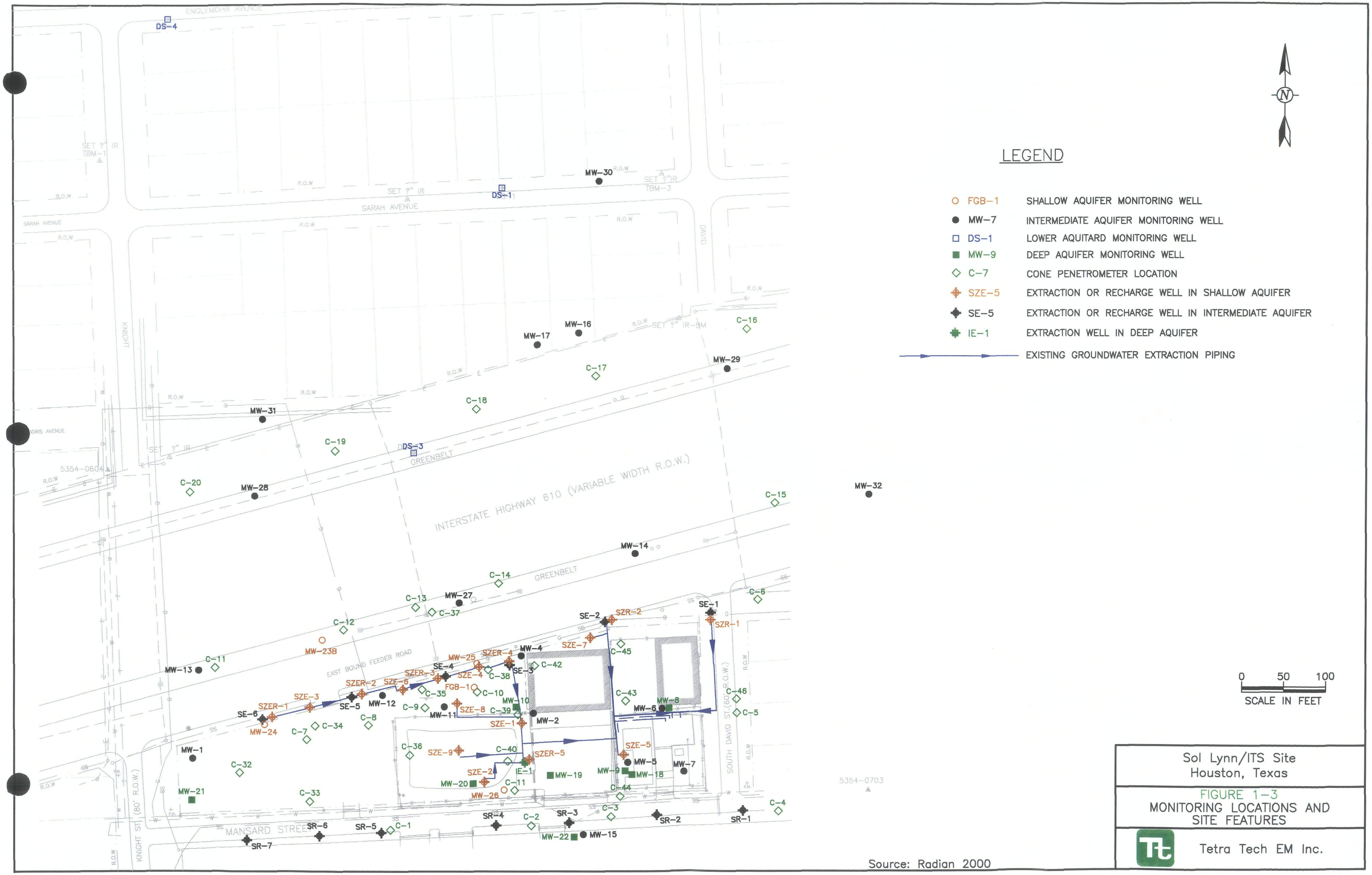


Sol Lynn/ITS Site
Houston, Texas

FIGURE 1–2
SITE MAP

Tetra Tech EM Inc.

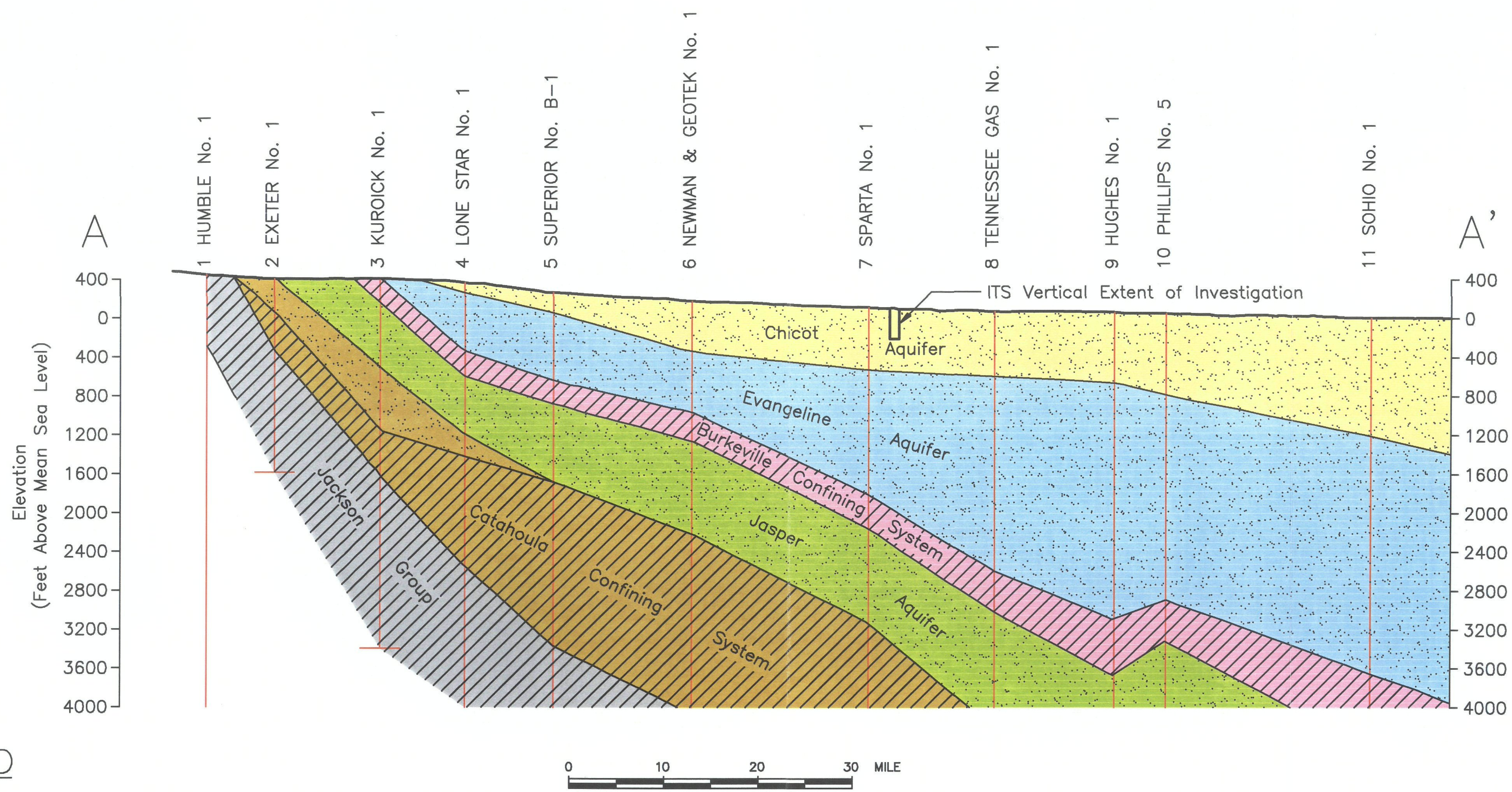
Data Source: Radian 1996



Sol Lynn/ITS Site
Houston, Texas

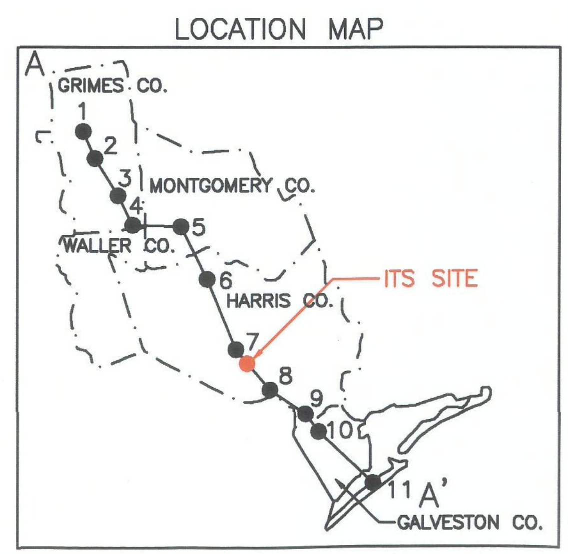
FIGURE 1-3
MONITORING LOCATIONS AND SITE FEATURES

Tetra Tech EM Inc.



LEGEND

- Beaumont and Lissie Formations
- Willis and Goliad Formations
- Lagarto Formation
- Fleming Formation
- Catahoula Sandstone
- Jackson Group
- Aquifer
- Confining System
- Geological and Geophysical Boring (Not in this study)



Source: Texas Department of Water Resources, Report 236, July 1979.

Sol Lynn/ITS Site
Houston, Texas

FIGURE 3-1
REGIONAL GEOLOGICAL AND HYDROGEOLOGICAL CROSS-SECTION

Tetra Tech EM Inc.

N

LEGEND

FGB-1	SHALLOW AQUIFER MONITORING WELL
MW-7	INTERMEDIATE AQUIFER MONITORING WELL
DS-1	LOWER AQUITARD MONITORING WELL
MW-9	DEEP AQUIFER MONITORING WELL
C-7	CONE PENETROMETER LOCATION
SZE-5	EXTRACTION OR RECHARGE WELL IN SHALLOW AQUIFER
SE-5	EXTRACTION OR RECHARGE WELL IN INTERMEDIATE AQUIFER
IE-1	EXTRACTION WELL IN DEEP AQUIFER
A — A'	CROSS-SECTION LINES

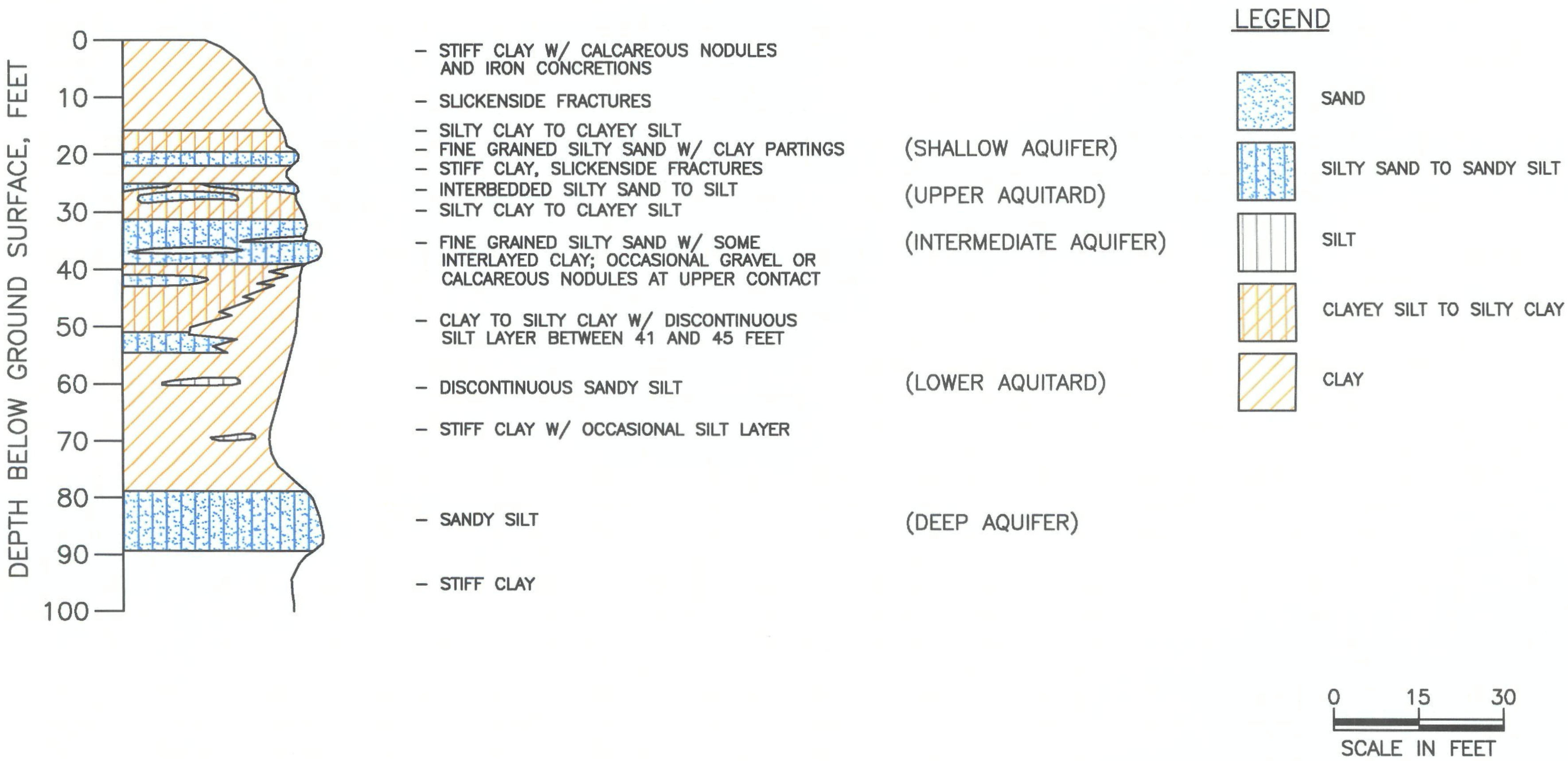
0 50 100
SCALE IN FEET

Source: Radian 2000

Sol Lynn/ITS Site
Houston, Texas

FIGURE 3-2
MONITORING WELL BORING LOCATIONS WITH CROSS SECTION LINES

Tetra Tech EM Inc.



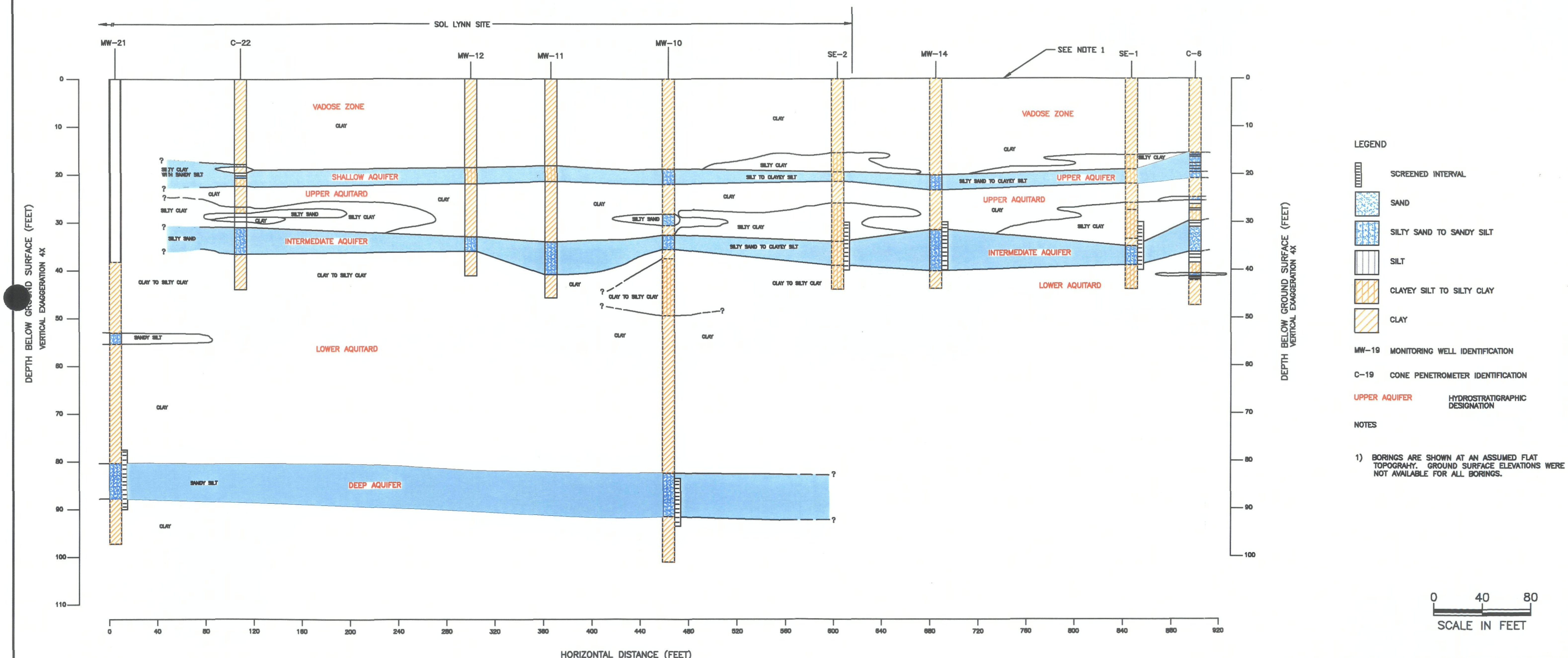
Sol Lynn/ITS Site
Houston, Texas

FIGURE 3–3

SCHEMATIC STRATIGRAPHIC COLUMN

Tetra Tech EM Inc.

Data Source: Radian 1991

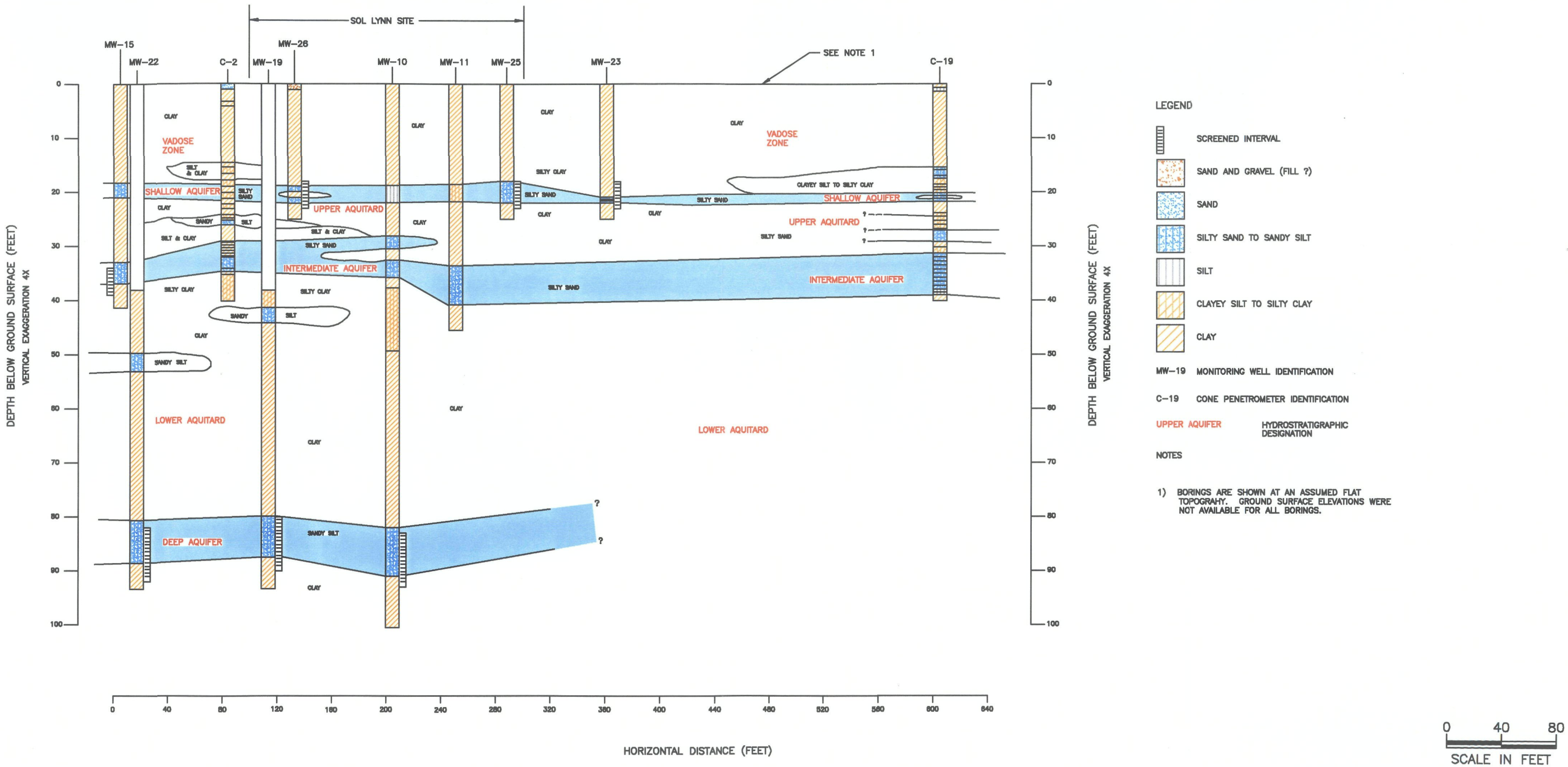


Sol Lynn/ITS Site
Houston, Texas

FIGURE 3-4
GEOLOGIC CROSS-SECTION A-A'

Tetra Tech EM Inc.

Data Source: Radian 1993

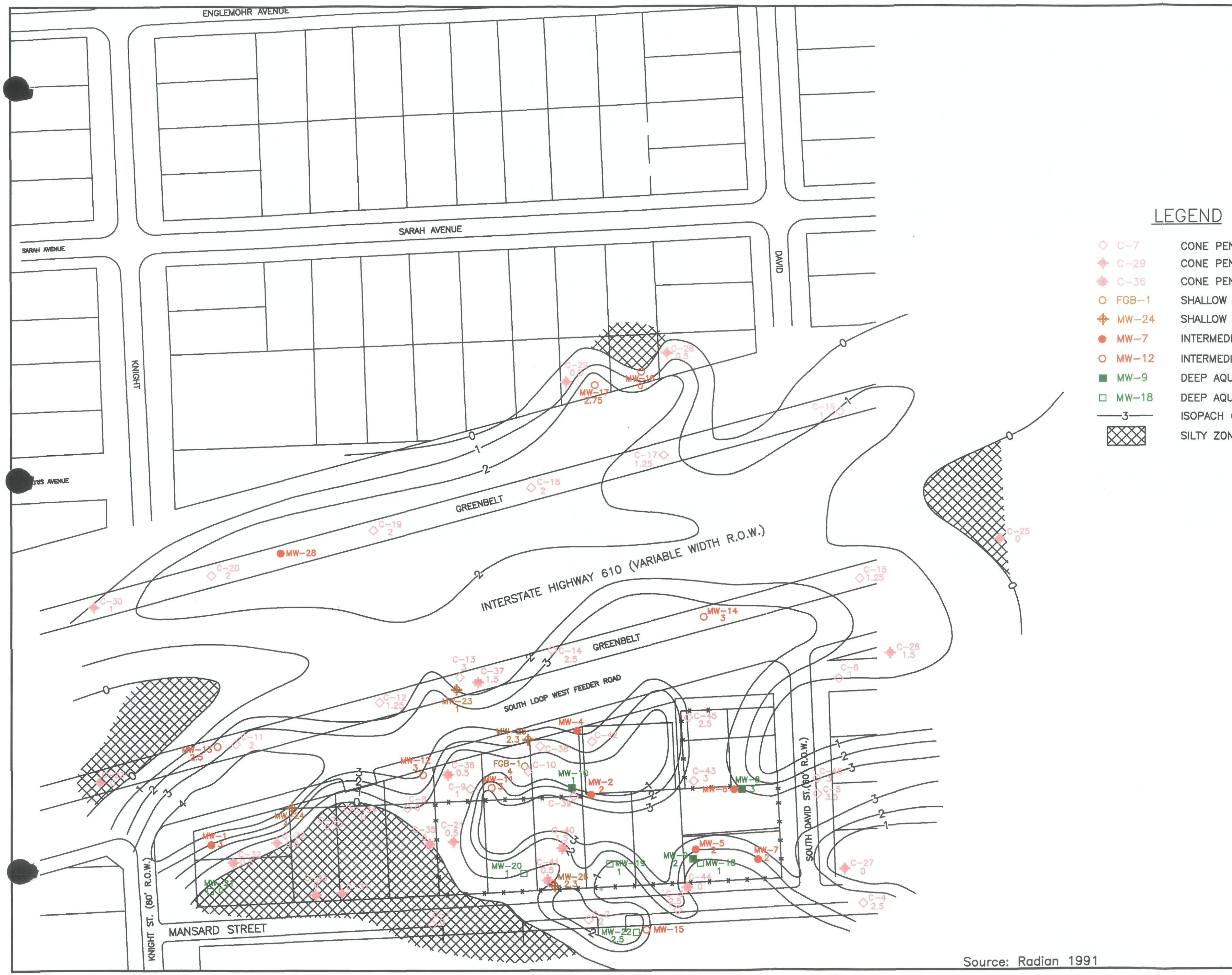


Sol Lynn/ITS Site
Houston, Texas

FIGURE 3-5
GEOLOGIC CROSS-SECTION B-B'

Tetra Tech EM Inc.

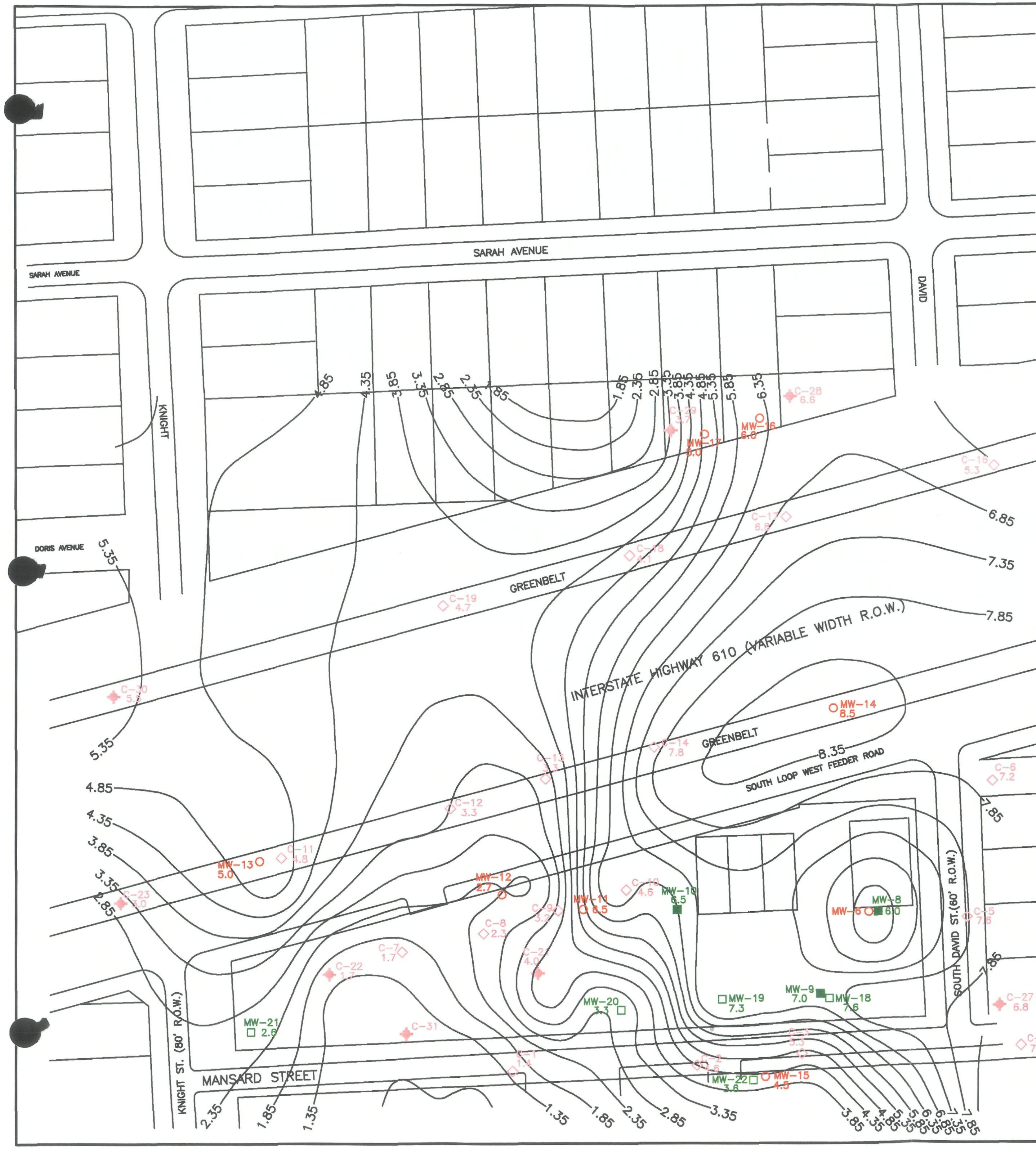
Data Source: Radian 1993



Sol Lynn/ITS Site
Houston, Texas

FIGURE 3-6
ISOPACH MAP, SILTY ZONE
(SHALLOW AQUIFER)

Tetra Tech EM Inc.



LEGEND

◇ C-7	CONE PENETROMETER LOCATION INSTALLED 3/88
✦ C-29	CONE PENETROMETER LOCATION INSTALLED 11/90
○ MW-12	UPPER SAND MONITORING WELL INSTALLED 12/90
■ MW-9	DEEP AQUIFER MONITORING WELL INSTALLED 1/88
□ MW-18	DEEP AQUIFER MONITORING WELL INSTALLED 1/91
1.85	ISOPACH CONTOUR LINE, THICKNESS IN FEET

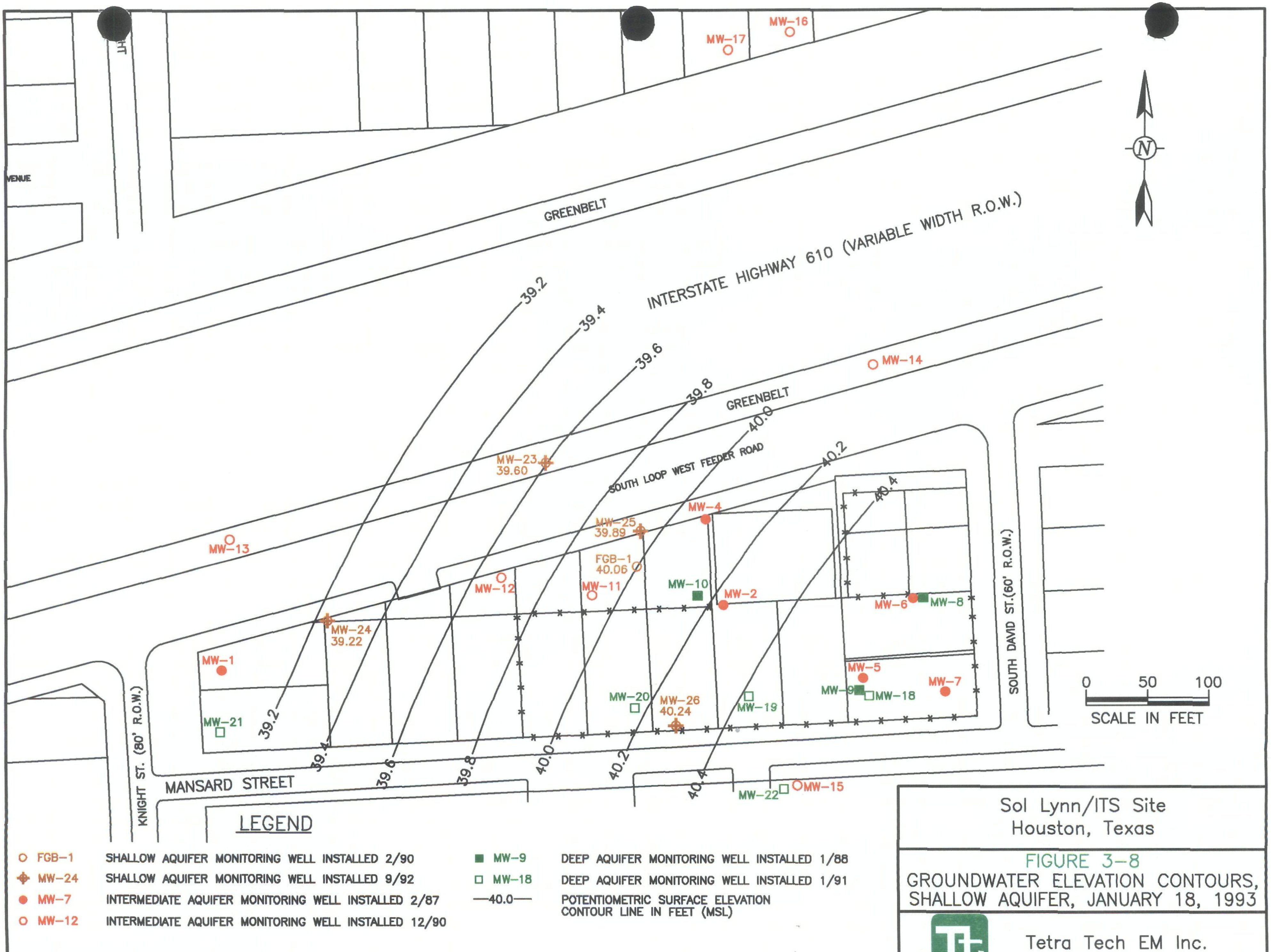
0 50 100
SCALE IN FEET

Source: Radian 1991

Sol Lynn/ITS Site
Houston, Texas

FIGURE 3-7
ISOPACH MAP, UPPER SAND
(INTERMEDIATE AQUIFER)

Tetra Tech EM Inc.



Source: Radian 1993

Sol Lynn/ITS Site
Houston, Texas

FIGURE 3-8
GROUNDWATER ELEVATION CONTOURS, SHALLOW AQUIFER, JANUARY 18, 1993

Tetra Tech EM Inc.

N

LEGEND

FGB-1	SHALLOW AQUIFER MONITORING WELL INSTALLED 2/90
MW-24	SHALLOW AQUIFER MONITORING WELL INSTALLED 9/92
MW-7	INTERMEDIATE AQUIFER MONITORING WELL INSTALLED 2/87
MW-12	INTERMEDIATE AQUIFER MONITORING WELL INSTALLED 12/90
MW-9	DEEP AQUIFER MONITORING WELL INSTALLED 1/88
MW-18	DEEP AQUIFER MONITORING WELL INSTALLED 1/91
—40.0—	POTENTIOMETRIC SURFACE ELEVATION CONTOUR LINE IN FEET (MSL)

0 50 100

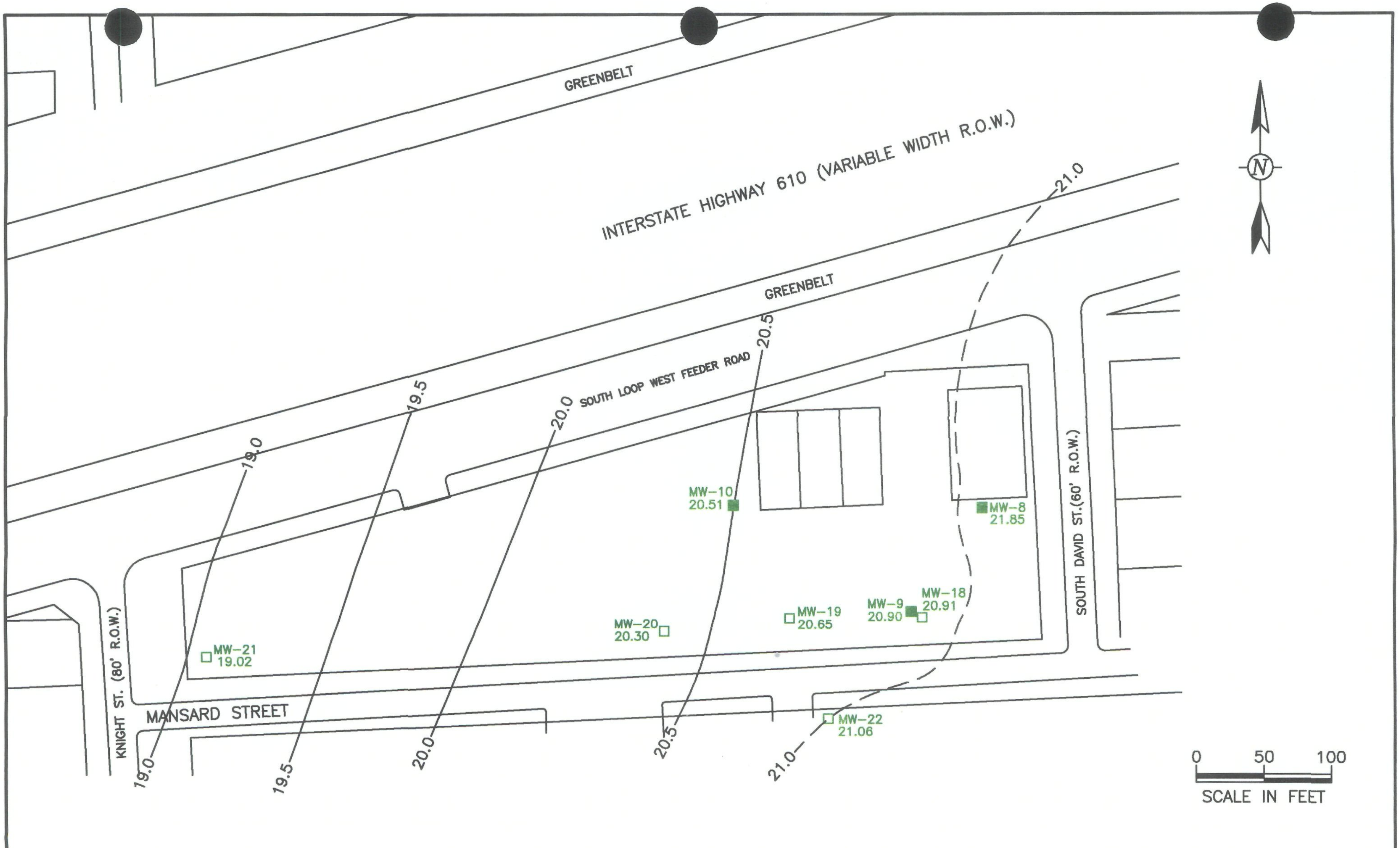
SCALE IN FEET

Source: Radian 1993

Sol Lynn/ITS Site
Houston, Texas

FIGURE 3-9
GROUNDWATER ELEVATION CONTOURS, INTERMEDIATE AQUIFER, JANUARY 18, 1993

Tetra Tech EM Inc.



LEGEND

■ MW-9	DEEP AQUIFER MONITORING WELL INSTALLED 1/88	20.65	ELEVATION (FT. MSL) OF WATER IN WELL (3-14-91)
□ MW-18	DEEP AQUIFER MONITORING WELL INSTALLED 1/91	——20.5	POTENTIOMETRIC SURFACE ELEVATION CONTOUR LINE IN FEET MSL (DASHED WHERE INFERRED)

Source: Radian 1991

Sol Lynn/ITS Site
Houston, Texas

FIGURE 3-10
GROUNDWATER ELEVATION CONTOURS, DEEP AQUIFER, MARCH 14, 1991

Tetra Tech EM Inc.

LEGEND

× 2862.3 — PRE-RI SURFACE SOIL AND SHALLOW BORING SAMPLING LOCATION WITH SOIL TCE CONCENTRATION IN mg/kg. THE EXACT SAMPLING DEPTHS OF PRE-RI SOIL SAMPLES ARE NOT AVAILABLE AND SOME SAMPLING LOCATIONS ARE ESTIMATED.

⊗ 0.5 — RI SURFACE SOIL SAMPLING LOCATION WITH SOIL TCE CONCENTRATION IN mg/kg (SAMPLING DEPTH WAS 0 TO 3 INCHES)

MW-06 55.5(0-2) — RI SOIL BORING SAMPLING LOCATION WITH SUBSURFACE SOIL TCE CONCENTRATIONS IN mg/kg AND DEPTH INTERVAL IN FEET (IN PARENTHESES)

ND — NOT DETECTED

SOIL TCE CONCENTRATION GREATER THAN 500 mg/kg

SOIL TCE CONCENTRATION BETWEEN 100 mg/kg AND 500 mg/kg

SOIL TCE CONCENTRATION BETWEEN 50 mg/kg AND 100 mg/kg

TCE CONCENTRATION CONTOUR

(A) — SOIL CONTAMINATION AREA

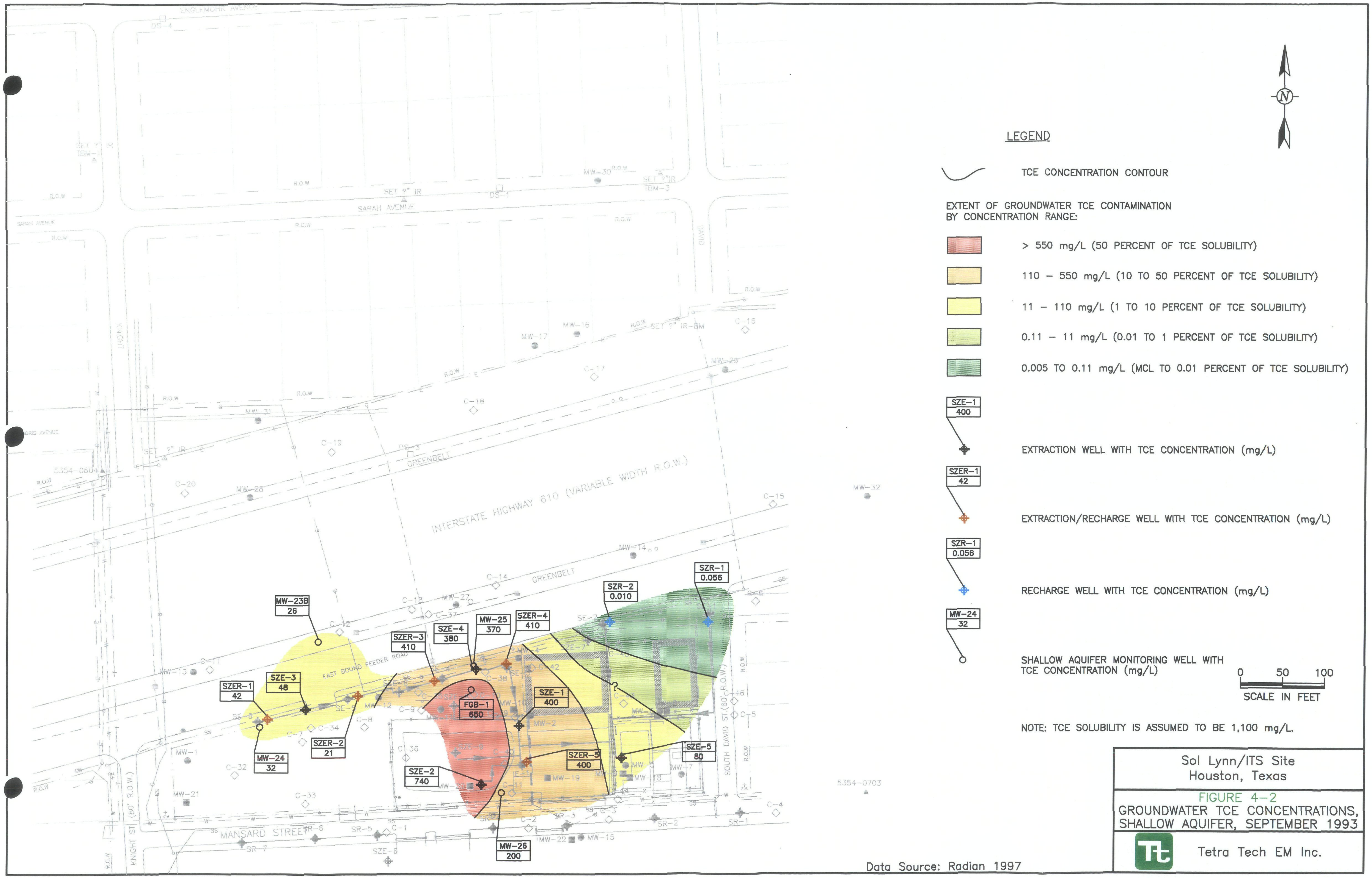
0 50 100
SCALE IN FEET

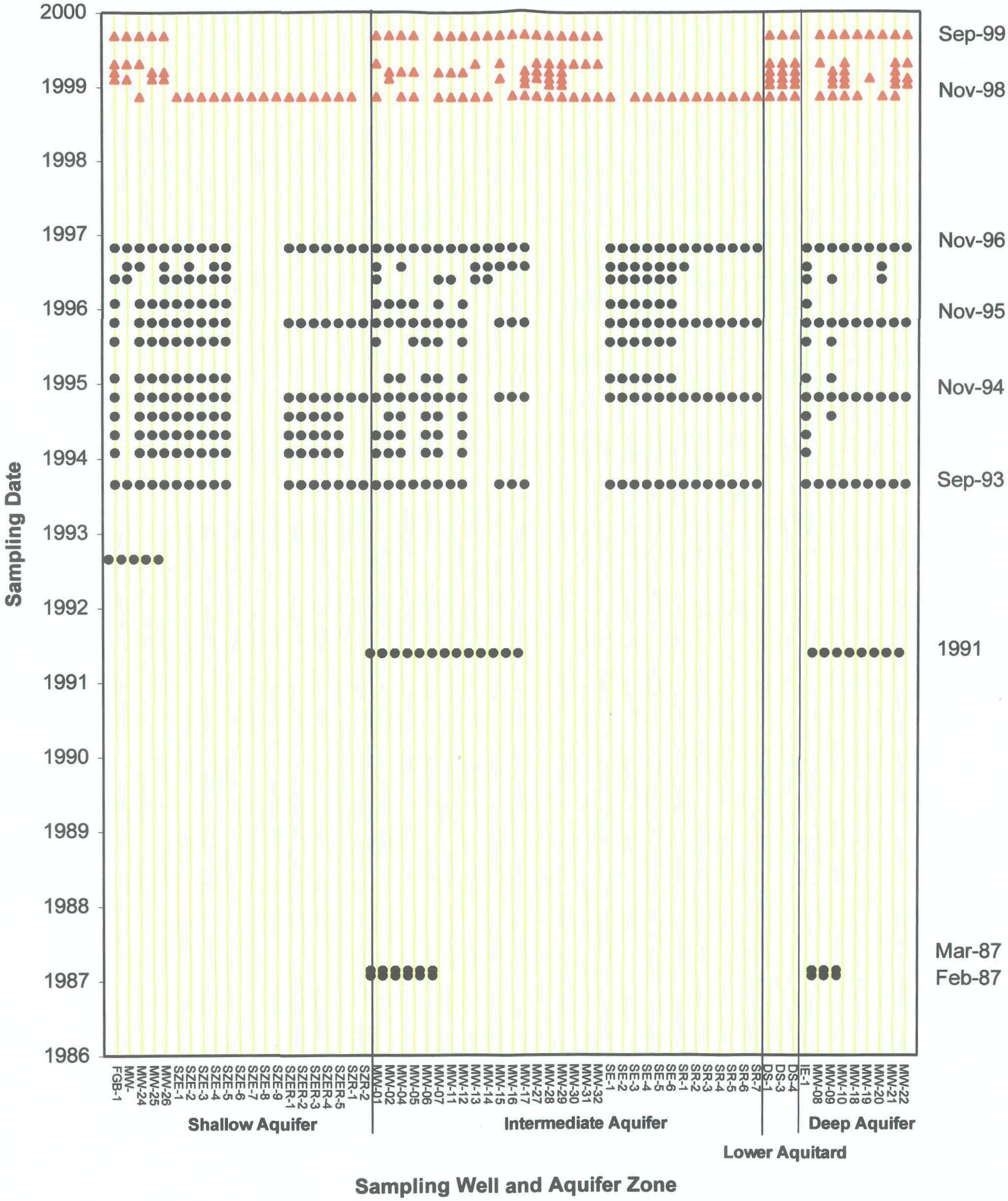
Data Source: Radian 1988

Sol Lynn/ITS Site
Houston, Texas

FIGURE 4-1
SURFACE AND SHALLOW SUBSURFACE SOIL TCE CONCENTRATION

Tetra Tech EM Inc.


LEGEND
TCE CONCENTRATION CONTOUR
EXTENT OF GROUNDWATER TCE CONTAMINATION BY CONCENTRATION RANGE:
> 550 mg/L (50 PERCENT OF TCE SOLUBILITY)
110 – 550 mg/L (10 TO 50 PERCENT OF TCE SOLUBILITY)
11 – 110 mg/L (1 TO 10 PERCENT OF TCE SOLUBILITY)
0.11 – 11 mg/L (0.01 TO 1 PERCENT OF TCE SOLUBILITY)
0.005 TO 0.11 mg/L (MCL TO 0.01 PERCENT OF TCE SOLUBILITY)
SZE–1 400
EXTRACTION WELL WITH TCE CONCENTRATION (mg/L)
SZER–1 42
EXTRACTION/RECHARGE WELL WITH TCE CONCENTRATION (mg/L)
SZR–1 0.056
RECHARGE WELL WITH TCE CONCENTRATION (mg/L)
MW–24 32
SHALLOW AQUIFER MONITORING WELL WITH TCE CONCENTRATION (mg/L)
0 50 100
SCALE IN FEET
NOTE: TCE SOLUBILITY IS ASSUMED TO BE 1,100 mg/L.
N
INTERSTATE HIGHWAY 610 (VARIABLE WIDTH R.O.W.)
MANSARD STREET
SOUTH DAVID ST. (60' R.O.W.)
KNIGHT ST. (80' R.O.W.)
SARAH AVENUE
GREENBELT
EAST BOUND FEEDER ROAD
MW–23B 26
MW–25 370
SZER–4 410
SZE–4 380
SZER–3 410
SZE–3 48
SZER–1 42
MW–24 32
SZER–2 21
FGB–1 650
SZE–1 400
SZE–2 740
MW–26 200
SZER–5 400
SZE–5 80
SZR–2 0.010
SZR–1 0.056
MW–32
Data Source: Radian 1997
Sol Lynn/ITS Site
Houston, Texas
FIGURE 4–2
GROUNDWATER TCE CONCENTRATIONS, SHALLOW AQUIFER, SEPTEMBER 1993
Tetra Tech EM Inc.



● Samples Analyzed for TCE

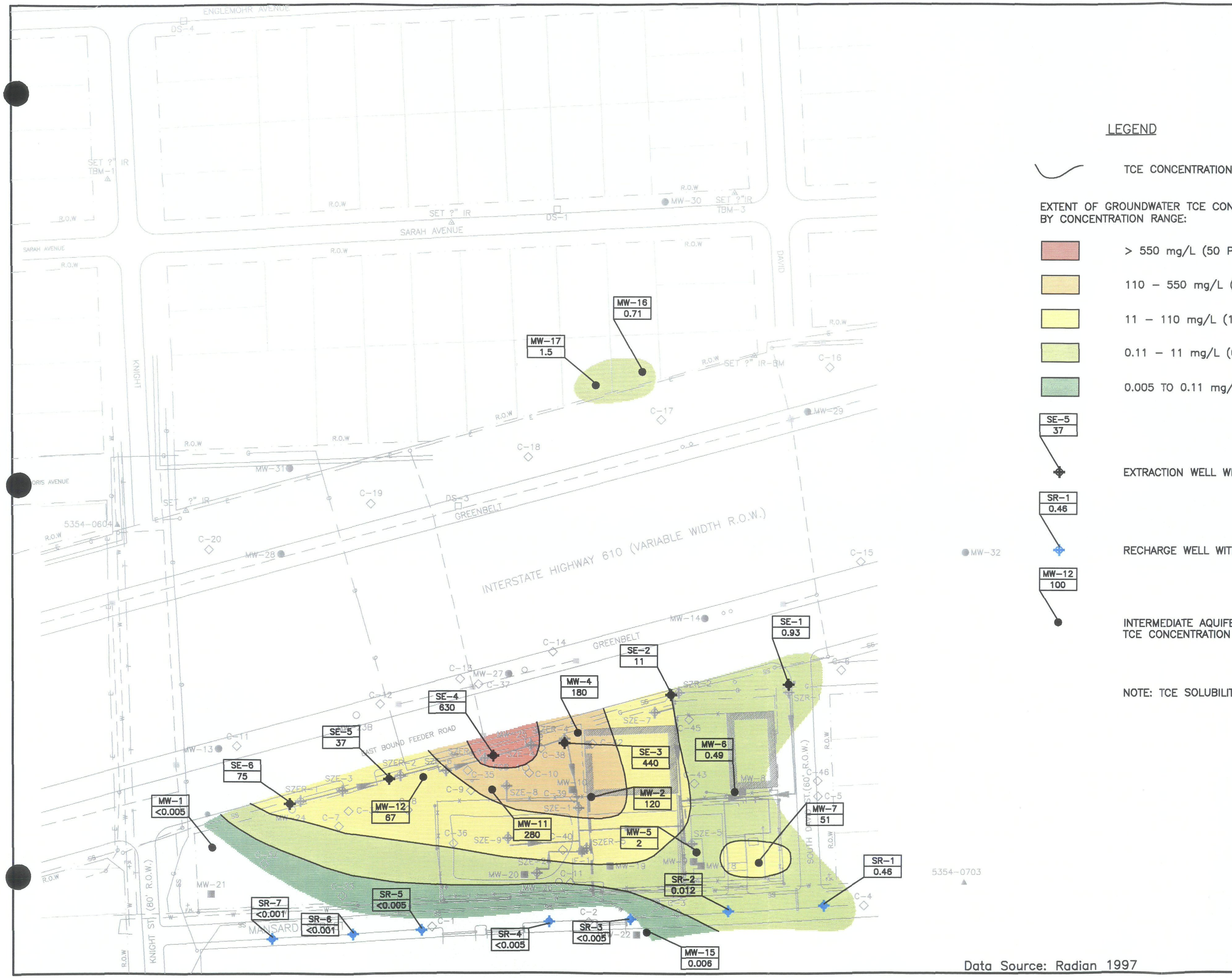
▲ Samples Analyzed for TCE, cis-1,2-DCE and Vinyl Chloride

Note:
The sampling time (month) for 1991 sampling event is unknown.

Sol Lynn/ITS Site
Houston, Texas

FIGURE 4-3
GROUNDWATER SAMPLE INVENTORY FOR CHLORINATED SOLVENT COMPOUNDS

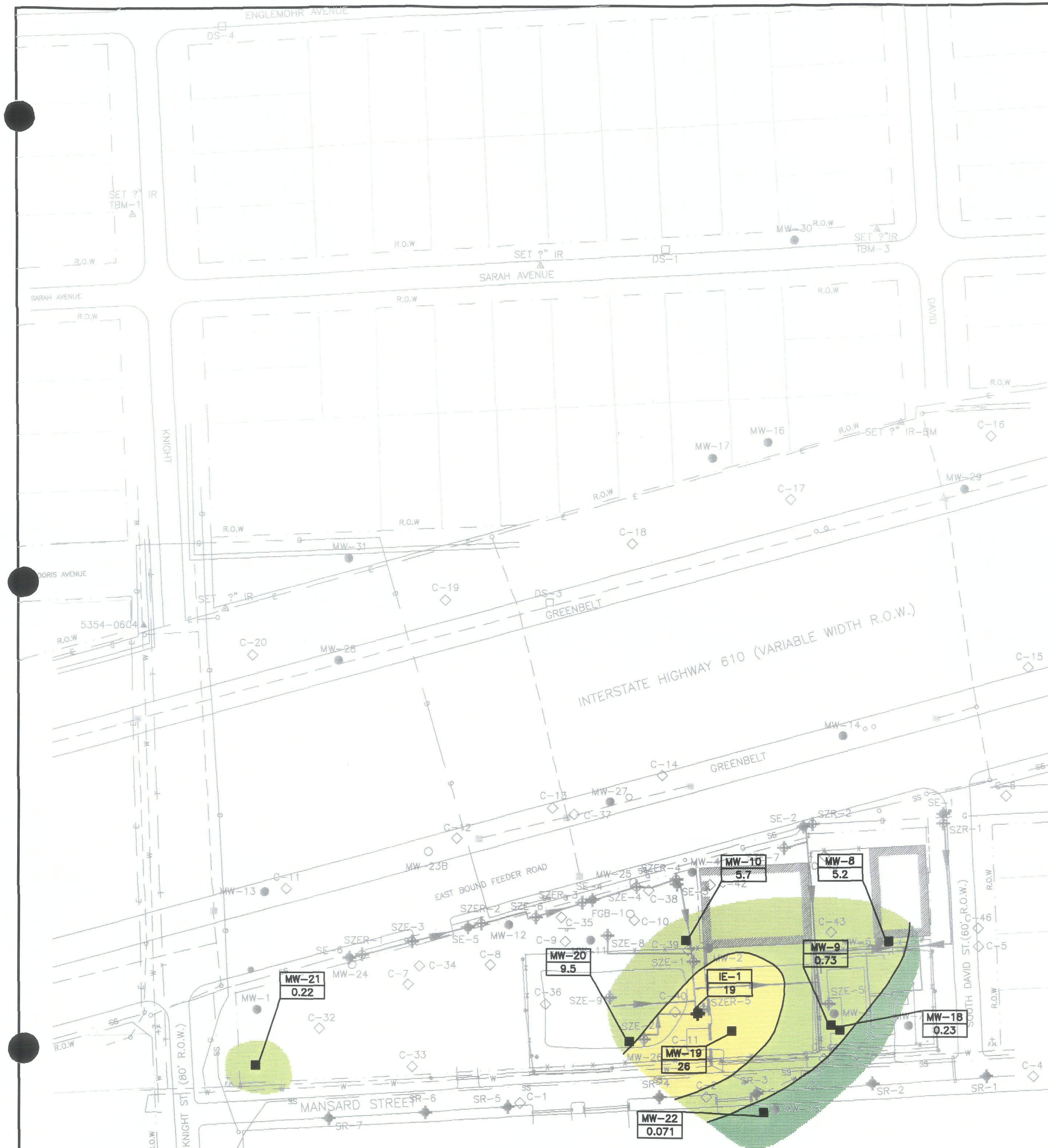
Tetra Tech EM Inc.



Sol Lynn/ITS Site
Houston, Texas

FIGURE 4–4
GROUNDWATER TCE CONCENTRATIONS, INTERMEDIATE AQUIFER, SEPTEMBER 1993

Tetra Tech EM Inc.



LEGEND

TCE CONCENTRATION CONTOUR

EXTENT OF GROUNDWATER TCE CONTAMINATION BY CONCENTRATION RANGE:

11 – 110 mg/L (1 TO 10 PERCENT OF TCE SOLUBILITY)

0.11 – 11 mg/L (0.01 TO 1 PERCENT OF TCE SOLUBILITY)

0.005 TO 0.11 mg/L (MCL TO 0.01 PERCENT OF TCE SOLUBILITY)

IE-1
19

EXTRACTION OR RECHARGE WELL WITH TCE CONCENTRATION (mg/L)

MW-10
5.7

DEEP AQUIFER MONITORING WELL WITH TCE CONCENTRATION (mg/L)

NOTE: TCE SOLUBILITY IS ASSUMED TO BE 1,100 mg/L.

N

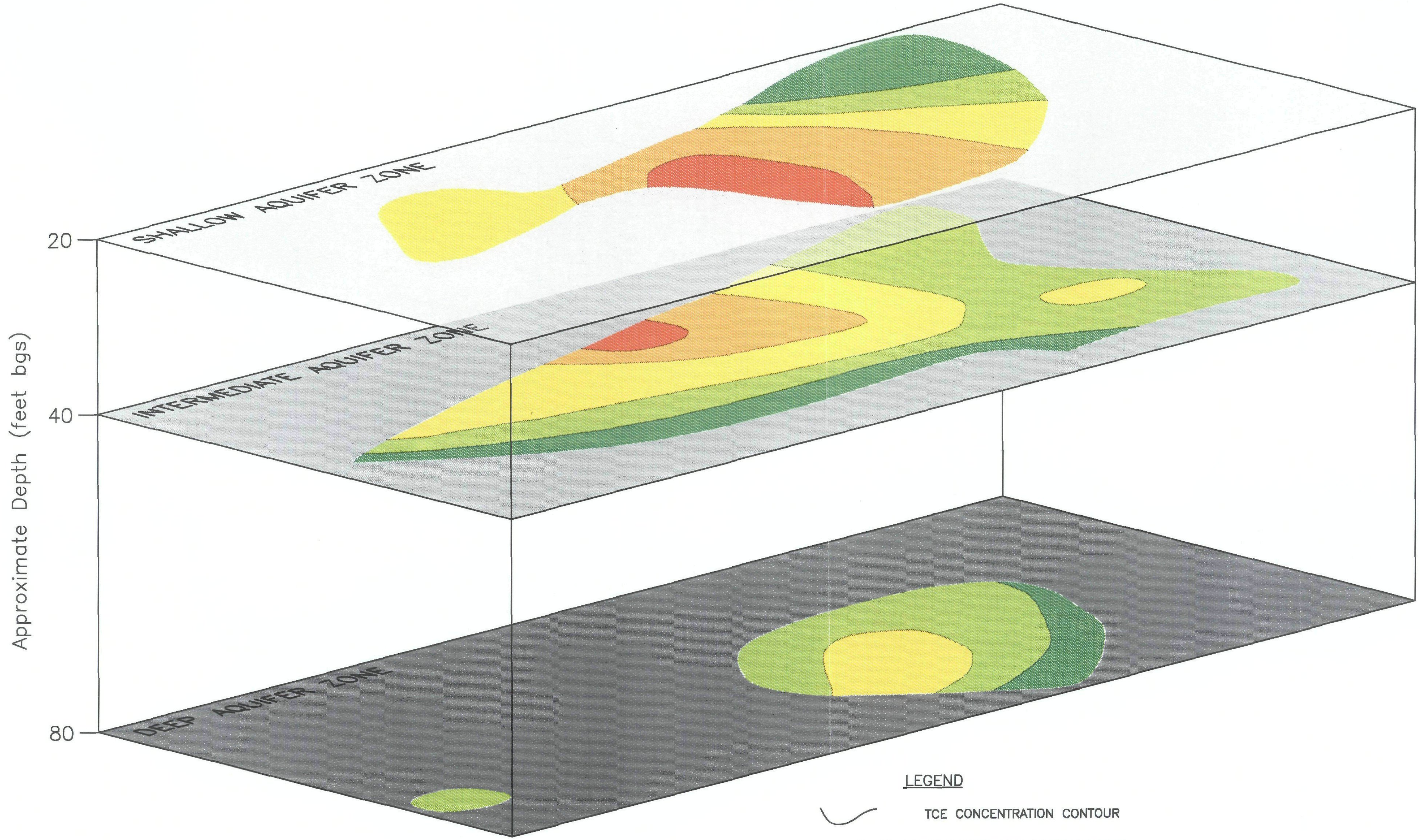
0 50 100
SCALE IN FEET

Data Source: Radian 1997

Sol Lynn/ITS Site
Houston, Texas

FIGURE 4–5
GROUNDWATER TCE CONCENTRATIONS, DEEP AQUIFER, SEPTEMBER 1993

Tetra Tech EM Inc.



LEGEND

TCE CONCENTRATION CONTOUR

EXTENT OF GROUNDWATER TCE CONTAMINATION
BY CONCENTRATION RANGE:

> 550 mg/L (50 PERCENT OF TCE SOLUBILITY)

110 – 550 mg/L (10 TO 50 PERCENT OF TCE SOLUBILITY)

11 – 110 mg/L (1 TO 10 PERCENT OF TCE SOLUBILITY)

0.11 – 11 mg/L (0.01 TO 1 PERCENT OF TCE SOLUBILITY)

0.005 TO 0.11 mg/L (MCL TO 0.01 PERCENT OF TCE SOLUBILITY)

NOT TO SCALE

Sol Lynn/ITS Site
Houston, Texas

FIGURE 4–6
3D REPRESENTATION OF GROUNDWATER
TCE PLUMES

Tetra Tech EM Inc.

Note: bgs – below ground surface

Data Source: Radian 1997

LEGEND

TCE CONCENTRATION CONTOUR

EXTENT OF GROUNDWATER TCE CONTAMINATION BY CONCENTRATION RANGE:

- 110 – 550 mg/L (10 TO 50 PERCENT OF TCE SOLUBILITY)
- 11 – 110 mg/L (1 TO 10 PERCENT OF TCE SOLUBILITY)
- 0.11 – 11 mg/L (0.01 TO 1 PERCENT OF TCE SOLUBILITY)
- 0.005 TO 0.11 mg/L (MCL TO 0.01 PERCENT OF TCE SOLUBILITY)

SZE-1 506 — EXTRACTION WELL WITH TCE CONCENTRATION (mg/L)

SZER-1 0.0022 — EXTRACTION/RECHARGE WELL WITH TCE CONCENTRATION (mg/L)

SZR-1 <0.001 — RECHARGE WELL WITH TCE CONCENTRATION (mg/L)

MW-24 19.4 — SHALLOW AQUIFER MONITORING WELL WITH TCE CONCENTRATION (mg/L)

NOTE: TCE SOLUBILITY IS ASSUMED TO BE 1,100 mg/L.

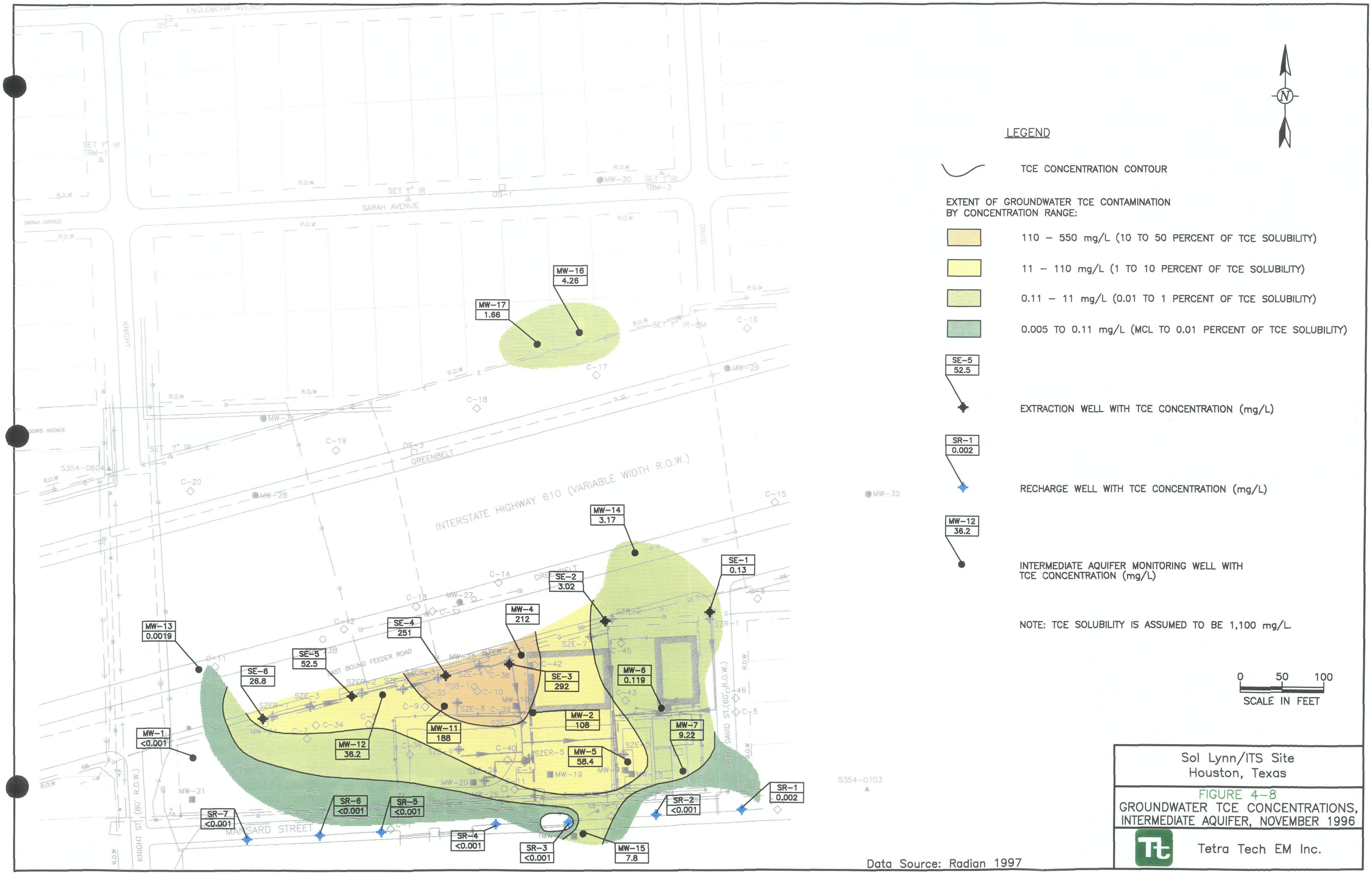
0 50 100
SCALE IN FEET

Data Source: Radian 1997

Sol Lynn/ITS Site
Houston, Texas

FIGURE 4–7
GROUNDWATER TCE CONCENTRATIONS, SHALLOW AQUIFER, NOVEMBER 1996

Tetra Tech EM Inc.



Sol Lynn/ITS Site
Houston, Texas

FIGURE 4–8
GROUNDWATER TCE CONCENTRATIONS, INTERMEDIATE AQUIFER, NOVEMBER 1996

Tetra Tech EM Inc.

LEGEND

TCE CONCENTRATION CONTOUR

EXTENT OF GROUNDWATER TCE CONTAMINATION BY CONCENTRATION RANGE:

0.11 – 11 mg/L (0.01 TO 1 PERCENT OF TCE SOLUBILITY)

0.005 TO 0.11 mg/L (MCL TO 0.01 PERCENT OF TCE SOLUBILITY)

MW-10
1.26

DEEP AQUIFER MONITORING WELL WITH TCE CONCENTRATION (mg/L)

IE-1
0.0168

EXTRACTION OR RECHARGE WELL WITH TCE CONCENTRATION (mg/L)

NOTE: TCE SOLUBILITY IS ASSUMED TO BE 1,100 mg/L.

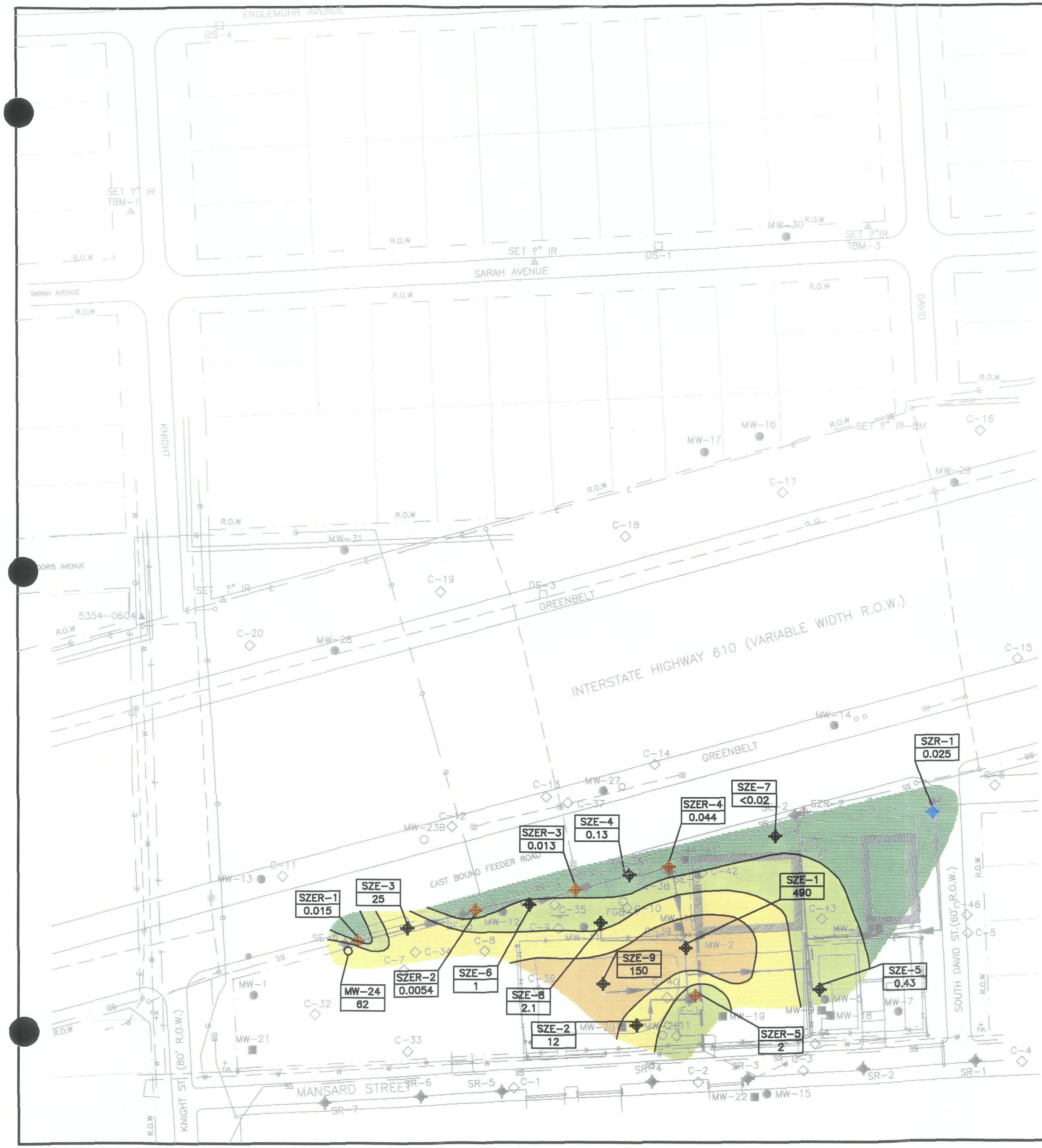
0 50 100
SCALE IN FEET

Data Source: Radian 1997

Sol Lynn/ITS Site
Houston, Texas

FIGURE 4-9
GROUNDWATER TCE CONCENTRATIONS, DEEP AQUIFER, NOVEMBER 1996

Tetra Tech EM Inc.



LEGEND

TCE CONCENTRATION CONTOUR

EXTENT OF GROUNDWATER TCE CONTAMINATION BY CONCENTRATION RANGE:

110 – 550 mg/L (10 TO 50 PERCENT OF TCE SOLUBILITY)

11 – 110 mg/L (1 TO 10 PERCENT OF TCE SOLUBILITY)

0.11 – 11 mg/L (0.01 TO 1 PERCENT OF TCE SOLUBILITY)

0.005 TO 0.11 mg/L (MCL TO 0.01 PERCENT OF TCE SOLUBILITY)

SZE-1 490 — EXTRACTION WELL WITH TCE CONCENTRATION (mg/L)

SZER-1 0.015 — EXTRACTION/RECHARGE WELL WITH TCE CONCENTRATION (mg/L)

SZR-1 0.025 — RECHARGE WELL WITH TCE CONCENTRATION (mg/L)

MW-24 62 — SHALLOW AQUIFER MONITORING WELL WITH TCE CONCENTRATION (mg/L)

NOTE: TCE SOLUBILITY IS ASSUMED TO BE 1,100 mg/L.

0 50 100

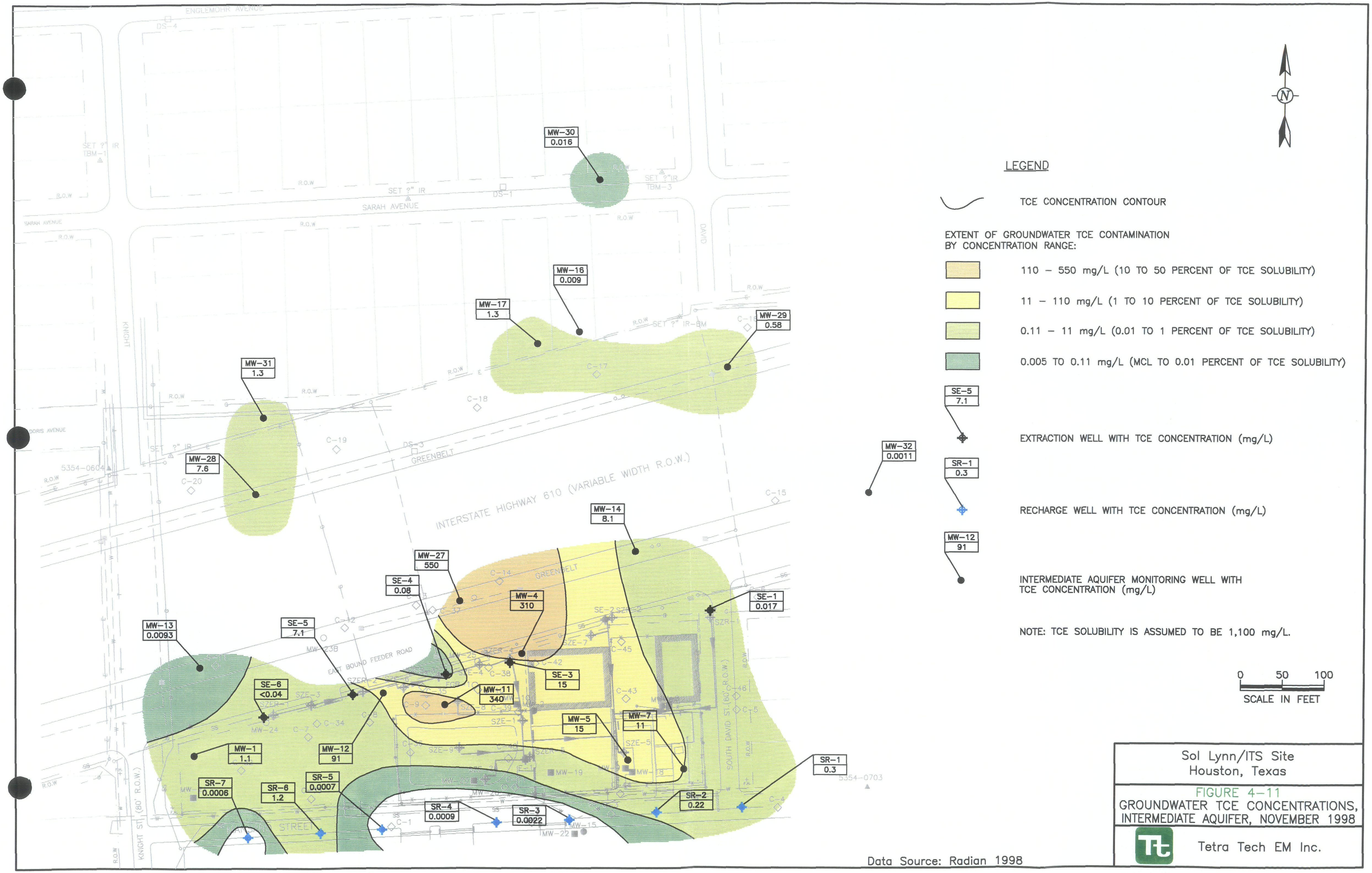
SCALE IN FEET

Data Source: Radian 1998

Sol Lynn/ITS Site
Houston, Texas

FIGURE 4–10
GROUNDWATER TCE CONCENTRATIONS, SHALLOW AQUIFER, NOVEMBER 1998

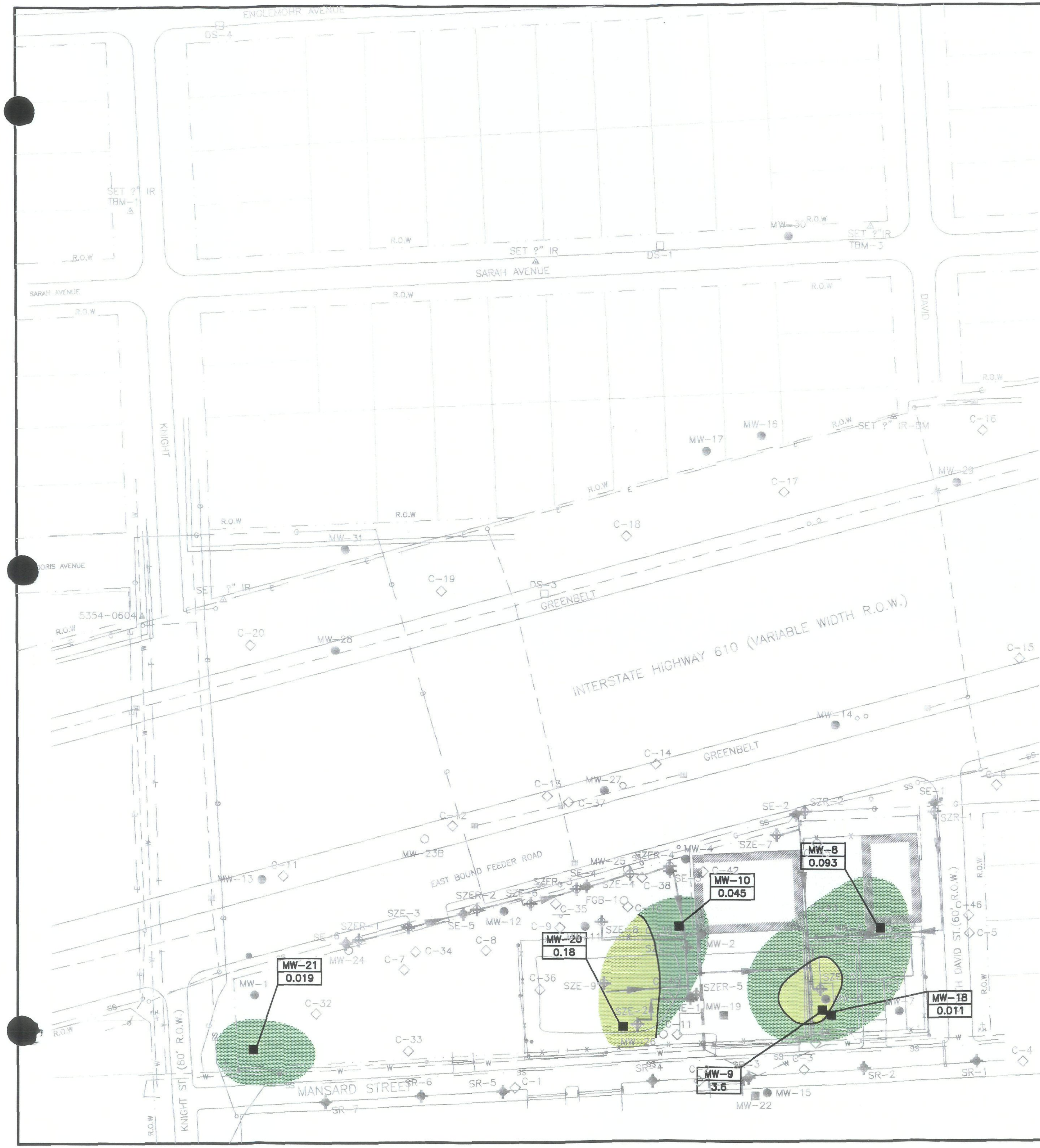
Tetra Tech EM Inc.



Sol Lynn/ITS Site
Houston, Texas

FIGURE 4–11
GROUNDWATER TCE CONCENTRATIONS,
INTERMEDIATE AQUIFER, NOVEMBER 1998

Tetra Tech EM Inc.



LEGEND

TCE CONCENTRATION CONTOUR

EXTENT OF GROUNDWATER TCE CONTAMINATION BY CONCENTRATION RANGE:

0.11 – 11 mg/L (0.01 TO 1 PERCENT OF TCE SOLUBILITY)

0.005 TO 0.11 mg/L (MCL TO 0.01 PERCENT OF TCE SOLUBILITY)

MW-10
0.045

DEEP AQUIFER MONITORING WELL WITH TCE CONCENTRATION (mg/L)

NOTE: TCE SOLUBILITY IS ASSUMED TO BE 1,100 mg/L.

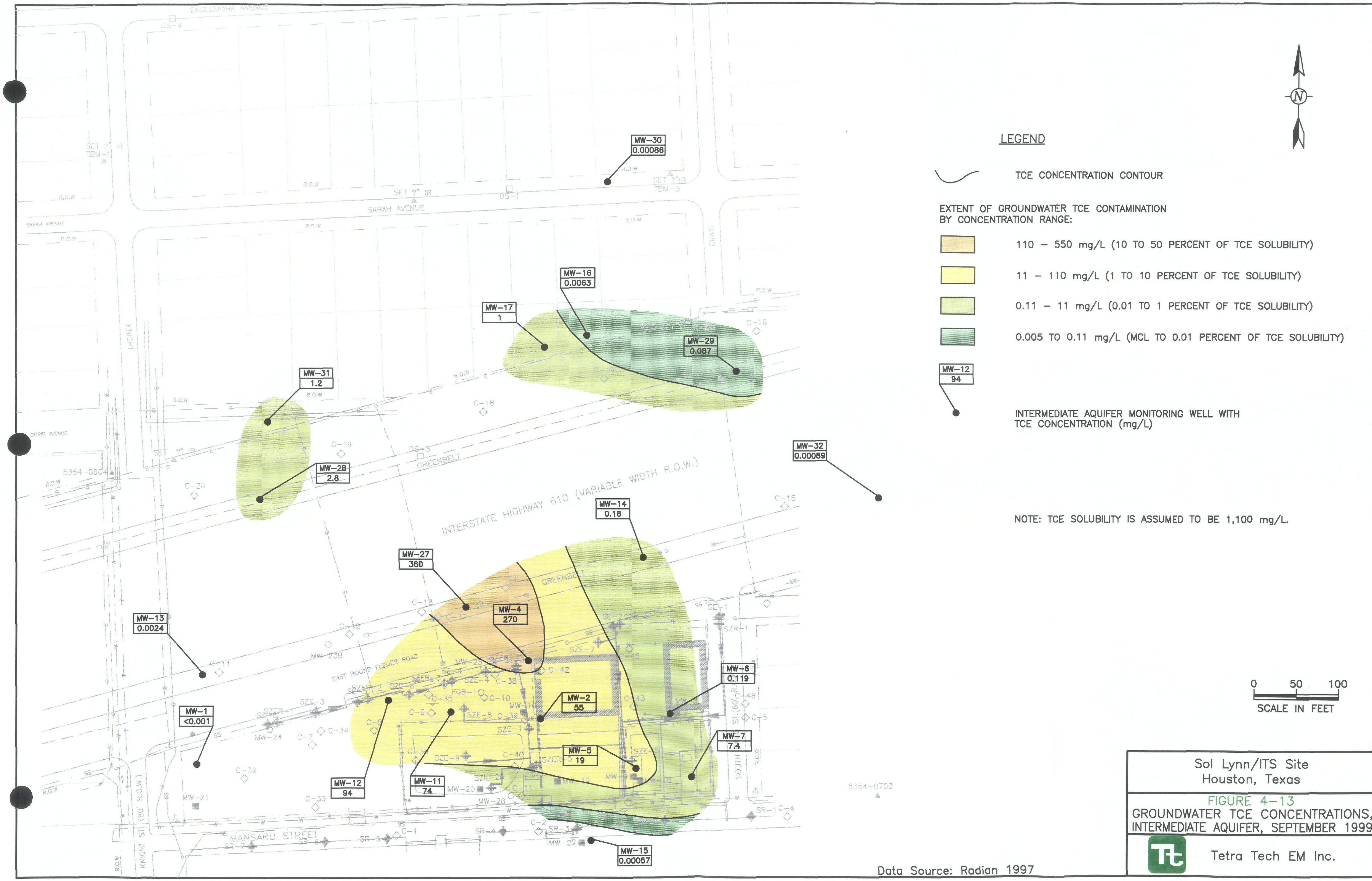
0 50 100
SCALE IN FEET

Data Source: Radian 1998

Sol Lynn/ITS Site
Houston, Texas

FIGURE 4–12
GROUNDWATER TCE CONCENTRATIONS, DEEP AQUIFER, NOVEMBER 1998

Tetra Tech EM Inc.

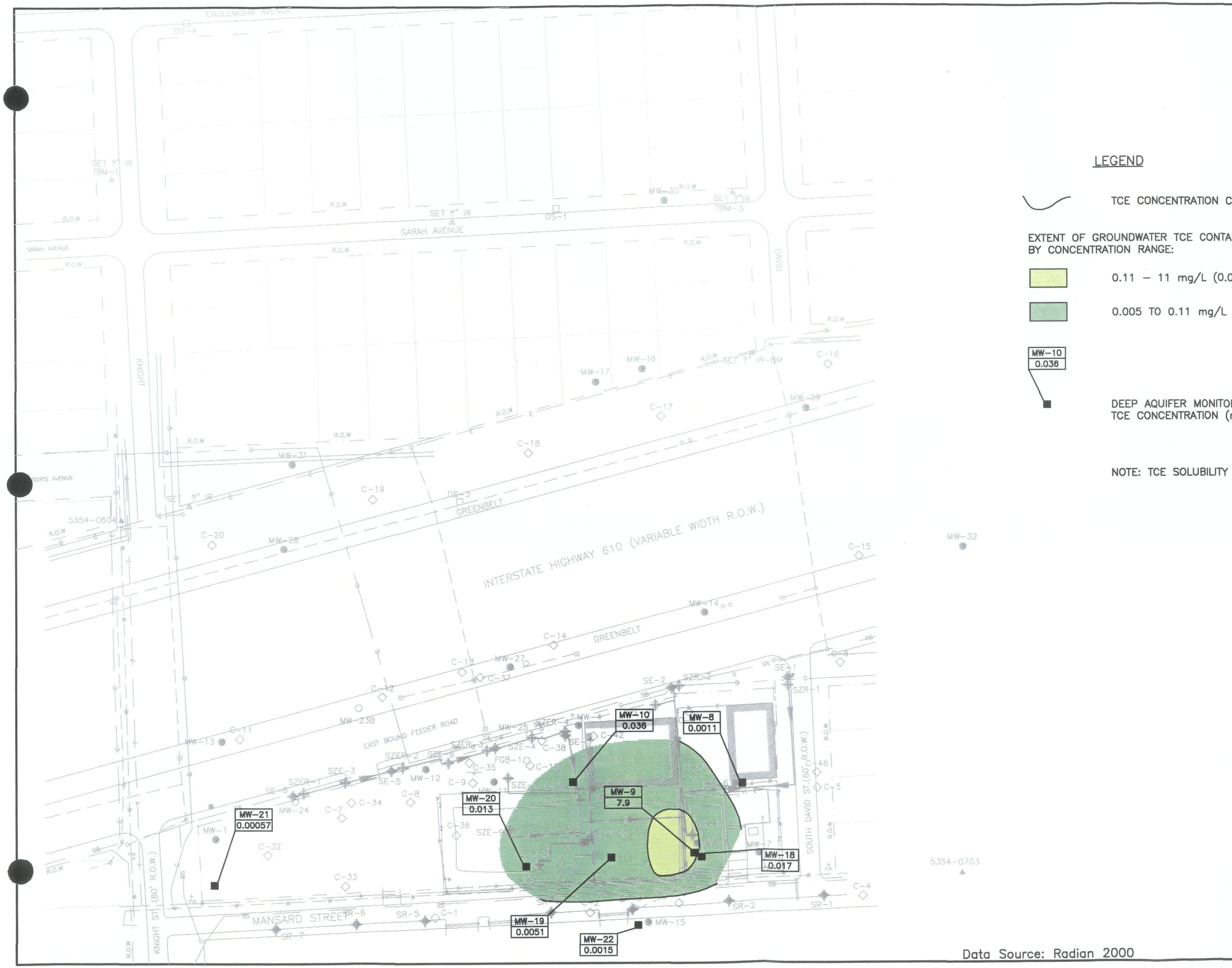


Data Source: Radian 1997

Sol Lynn/ITS Site
Houston, Texas

FIGURE 4–13
GROUNDWATER TCE CONCENTRATIONS, INTERMEDIATE AQUIFER, SEPTEMBER 1999

Tetra Tech EM Inc.



Sol Lynn/ITS Site
Houston, Texas

FIGURE 4–14
GROUNDWATER TCE CONCENTRATIONS, DEEP AQUIFER, SEPTEMBER 1999

Tetra Tech EM Inc.

LEGEND

CIS-1,2-DCE CONCENTRATION CONTOUR

EXTENT OF GROUNDWATER CIS1,2-DCE CONTAMINATION BY CONCENTRATION RANGE:

> 350 mg/L (GREATER THAN 10 PERCENT OF CIS-1,2-DCE SOLUBILITY)

35 – 350 mg/L (1 TO 10 PERCENT OF CIS-1,2-DCE SOLUBILITY)

0.35 – 35 mg/L (0.01 TO 1 PERCENT OF CIS-1,2-DCE SOLUBILITY)

0.07 – .35 mg/L (MCL TO 0.01 PERCENT OF CIS-1,2-DCE SOLUBILITY)

MW-12
31

INTERMEDIATE AQUIFER MONITORING WELL WITH CIS-1,2-DCE CONCENTRATION (mg/L)

NOTE: CIS-1,2-DCE SOLUBILITY IS ASSUMED TO BE 3,500 mg/L.

0 50 100
SCALE IN FEET

Data Source: Radian 2000

Sol Lynn/ITS Site
Houston, Texas

FIGURE 4-15
GROUNDWATER CIS-1,2-DCE CONCENTRATIONS, INTERMEDIATE AQUIFER, SEPTEMBER 1999

Tetra Tech EM Inc.

LEGEND

MW-10
<0.001

DEEP AQUIFER MONITORING WELL WITH CIS-1,2-DCE CONCENTRATION (mg/L)

NOTE: CIS-1,2-DCE SOLUBILITY IS ASSUMED TO BE 3,500 mg/L.

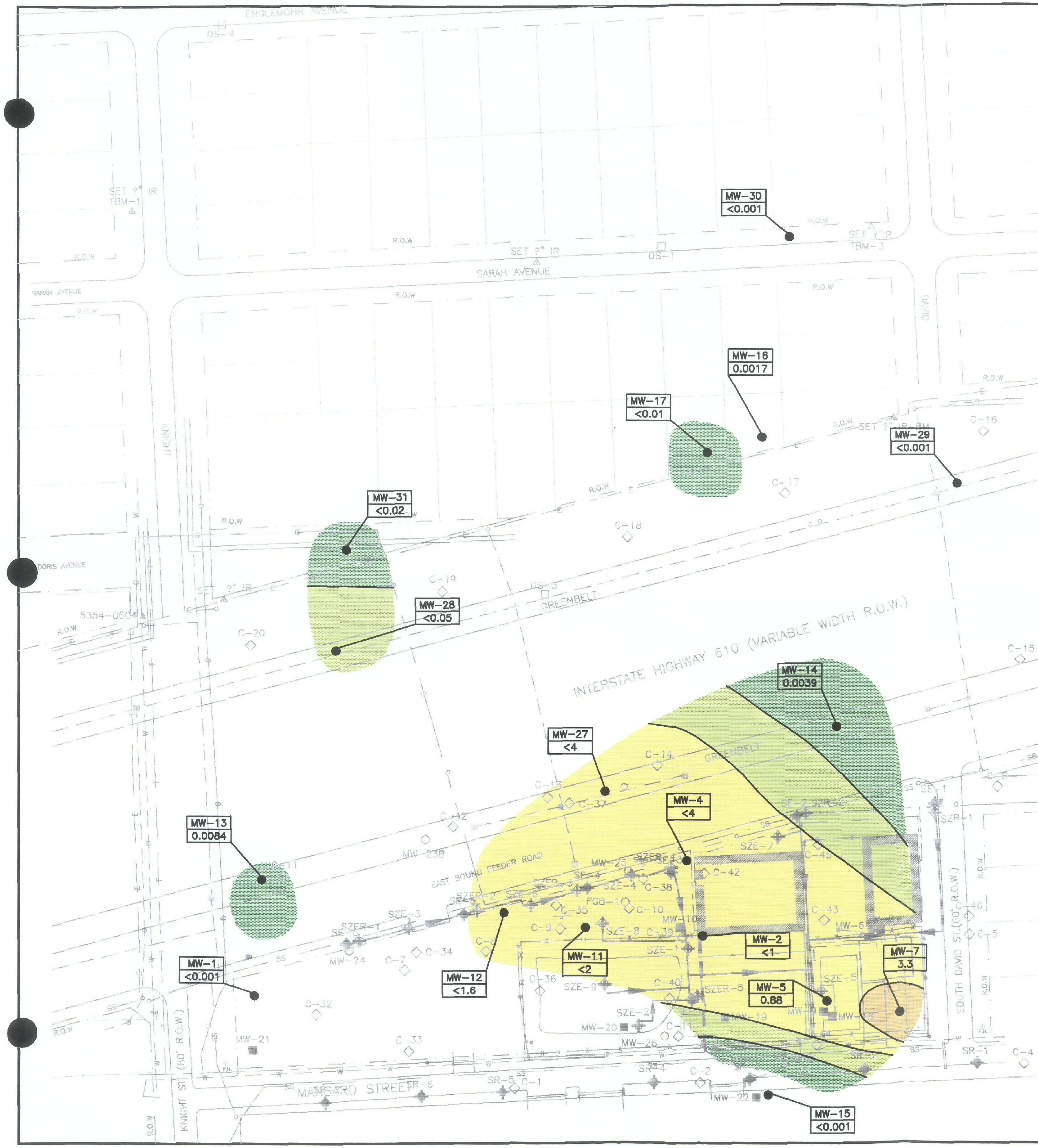
0 50 100
SCALE IN FEET

Data Source: Radian

Sol Lynn/ITS Site
Houston, Texas

FIGURE 4-16
GROUNDWATER CIS-1,2-DCE CONCENTRATIONS, DEEP AQUIFER, SEPTEMBER 1999

Tetra Tech EM Inc.



LEGEND

VINYL CHLORIDE CONCENTRATION CONTOUR

EXTENT OF GROUNDWATER VINYL CHLORIDE CONTAMINATION BY CONCENTRATION RANGE:

- > 2 mg/L (GREATER THAN 10 PERCENT OF VINYL CHLORIDE SOLUBILITY)
- 0.2 – 2 mg/L (1 TO 10 PERCENT OF VINYL CHLORIDE SOLUBILITY)
- 0.02 – 0.2 mg/L (0.01 TO 1 PERCENT OF VINYL CHLORIDE SOLUBILITY)
- 0.002 – 0.02 mg/L (MCL TO 0.01 PERCENT OF VINYL CHLORIDE SOLUBILITY)

MW-12
<1.6

INTERMEDIATE AQUIFER MONITORING WELL WITH VINYL CHLORIDE CONCENTRATION (mg/L)

0 50 100
SCALE IN FEET

Data Source: Radian 2000

Sol Lynn/ITS Site
Houston, Texas

FIGURE 4-17
VINYL CHLORIDE CONCENTRATIONS, INTERMEDIATE AQUIFER, SEPTEMBER 1999

Tetra Tech EM Inc.

Data Source: Radian 1988, 1997, 1998, 2000

LEGEND

SZE-1 / 770 / FEB-95	WELL IDENTIFICATION MAXIMUM TCE CONCENTRATION (mg/L) SAMPLING DATE
(large red circle)	MAXIMUM TCE CONCENTRATION > 110 mg/L (GREATER THAN 10 PERCENT OF TCE SOLUBILITY)
(small red circle)	MAXIMUM TCE CONCENTRATION FROM 11 TO 110 mg/L (BETWEEN 1 AND 10 PERCENT OF TCE SOLUBILITY)
(green dot)	MAXIMUM TCE CONCENTRATION < 11 mg/L (LESS THAN 1 PERCENT OF TCE SOLUBILITY)

NOTE: TCE SOLUBILITY IS ASSUMED TO BE 1,100 mg/L.

0 50 100
SCALE IN FEET

Sol Lynn/ITS Site
Houston, Texas

FIGURE 4-18
MAXIMUM TCE CONCENTRATION DETECTED IN SHALLOW AQUIFER

Tetra Tech EM Inc.

LEGEND

SE-5 85 NOV-94	WELL IDENTIFICATION MAXIMUM TCE CONCENTRATION (mg/L) SAMPLING DATE
● (large red)	MAXIMUM TCE CONCENTRATION > 110 mg/L (GREATER THAN 10 PERCENT OF TCE SOLUBILITY)
● (small red)	MAXIMUM TCE CONCENTRATION FROM 11 TO 110 mg/L (BETWEEN 1 AND 10 PERCENT OF TCE SOLUBILITY)
● (green)	MAXIMUM TCE CONCENTRATION < 11 mg/L (LESS THAN 1 PERCENT OF TCE SOLUBILITY)

NOTE: TCE SOLUBILITY IS ASSUMED TO BE 1,100 mg/L.

0 50 100
SCALE IN FEET

Data Source: Radian 1988, 1997, 1998, 2000

Sol Lynn/ITS Site
Houston, Texas

FIGURE 4-19
MAXIMUM TCE CONCENTRATION DETECTED IN INTERMEDIATE AQUIFER

Tetra Tech EM Inc.

LEGEND

DS-3 / 38 / SEP-99	WELL IDENTIFICATION MAXIMUM TCE CONCENTRATION (mg/L) SAMPLING DATE
● (red)	MAXIMUM TCE CONCENTRATION FROM 11 TO 110 mg/L (BETWEEN 1 AND 10 PERCENT OF TCE SOLUBILITY)
● (green)	MAXIMUM TCE CONCENTRATION < 11 mg/L (LESS THAN 1 PERCENT OF TCE SOLUBILITY)

NOTE: TCE SOLUBILITY IS ASSUMED TO BE 1,100 mg/L.

0 50 100

SCALE IN FEET

Data Source: Radian 1988, 1997, 1998, 2000

Sol Lynn/ITS Site
Houston, Texas

FIGURE 4-20
MAXIMUM TCE CONCENTRATION
DETECTED IN LOWER AQUITARD

Tetra Tech EM Inc.

LEGEND

MW-10 / 5.7 / SEP-93	WELL IDENTIFICATION MAXIMUM TCE CONCENTRATION (mg/L) SAMPLING DATE
(orange dot)	MAXIMUM TCE CONCENTRATION FROM 11 TO 110 mg/L (BETWEEN 1 AND 10 PERCENT OF TCE SOLUBILITY)
(green dot)	MAXIMUM TCE CONCENTRATION < 11 mg/L (LESS THAN 1 PERCENT OF TCE SOLUBILITY)

NOTE: TCE SOLUBILITY IS ASSUMED TO BE 1,100 mg/L.

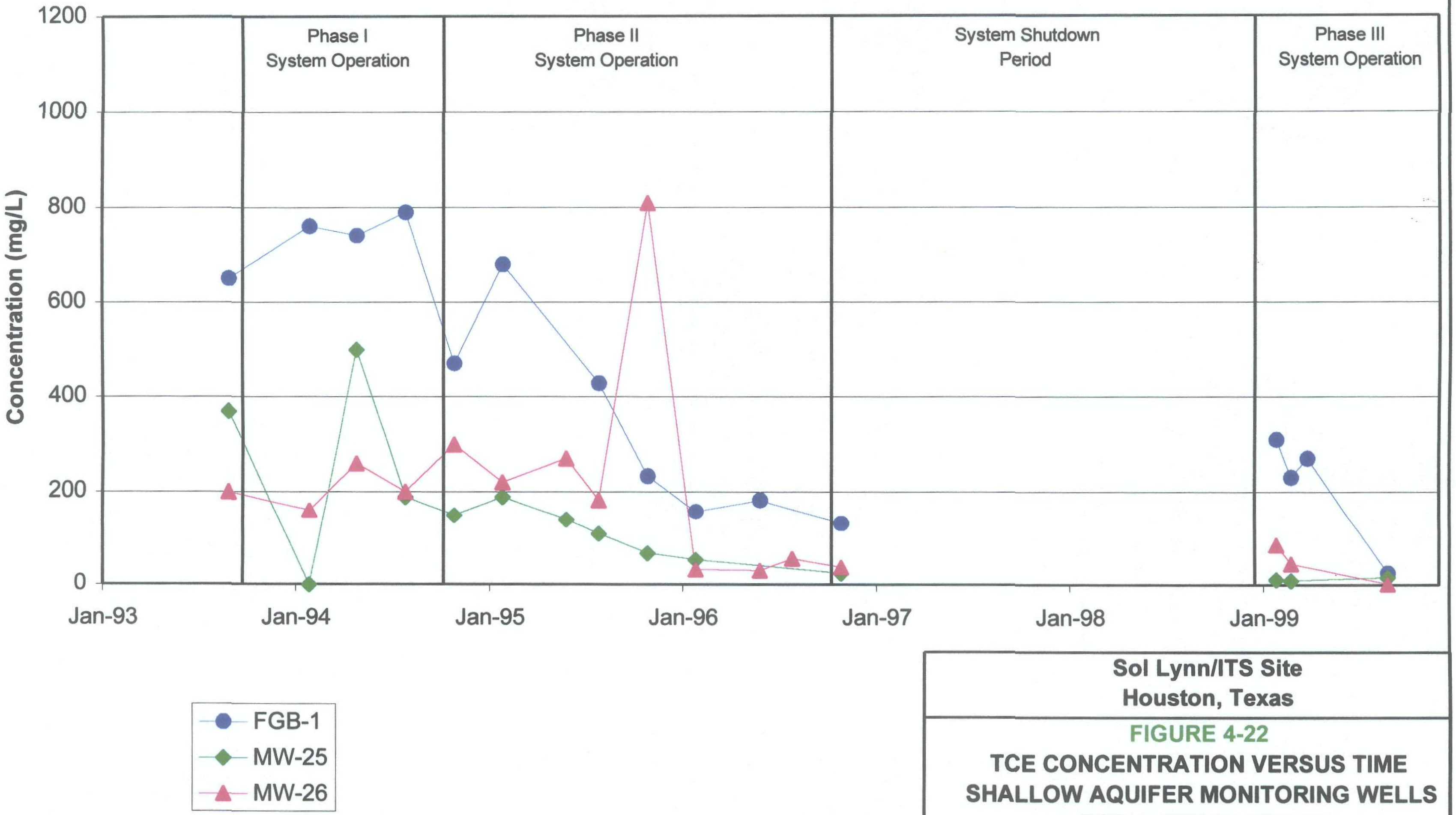
0 50 100
SCALE IN FEET

Data Source: Radian 1988, 1997, 1998, 2000

Sol Lynn/ITS Site
Houston, Texas

FIGURE 4-21
MAXIMUM TCE CONCENTRATION DETECTED IN DEEP AQUIFER

Tetra Tech EM Inc.

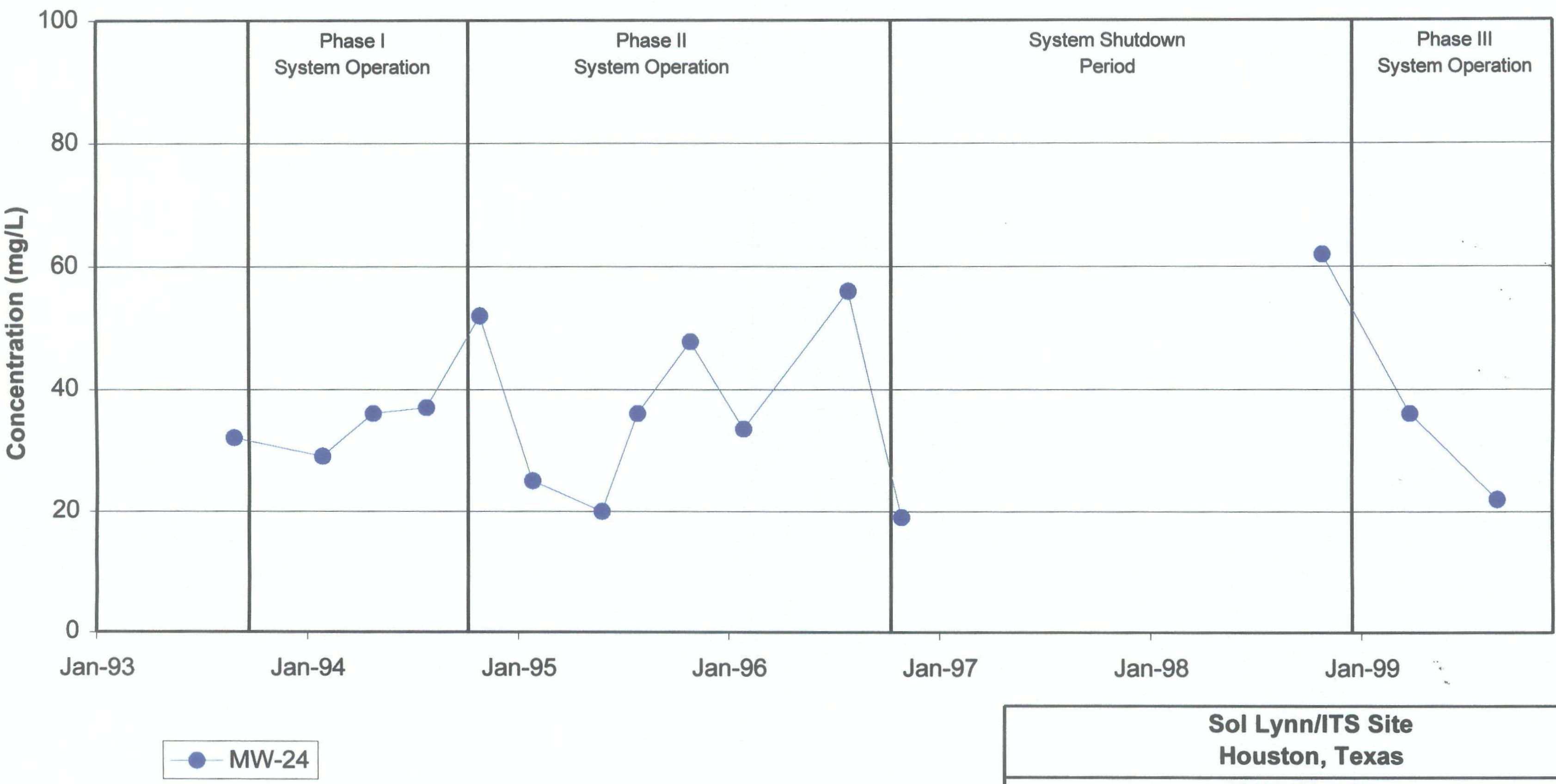


Sol Lynn/ITS Site
Houston, Texas

FIGURE 4-22

TCE CONCENTRATION VERSUS TIME
SHALLOW AQUIFER MONITORING WELLS
FGB-1, MW-25, MW-26

Tetra Tech EM Inc.

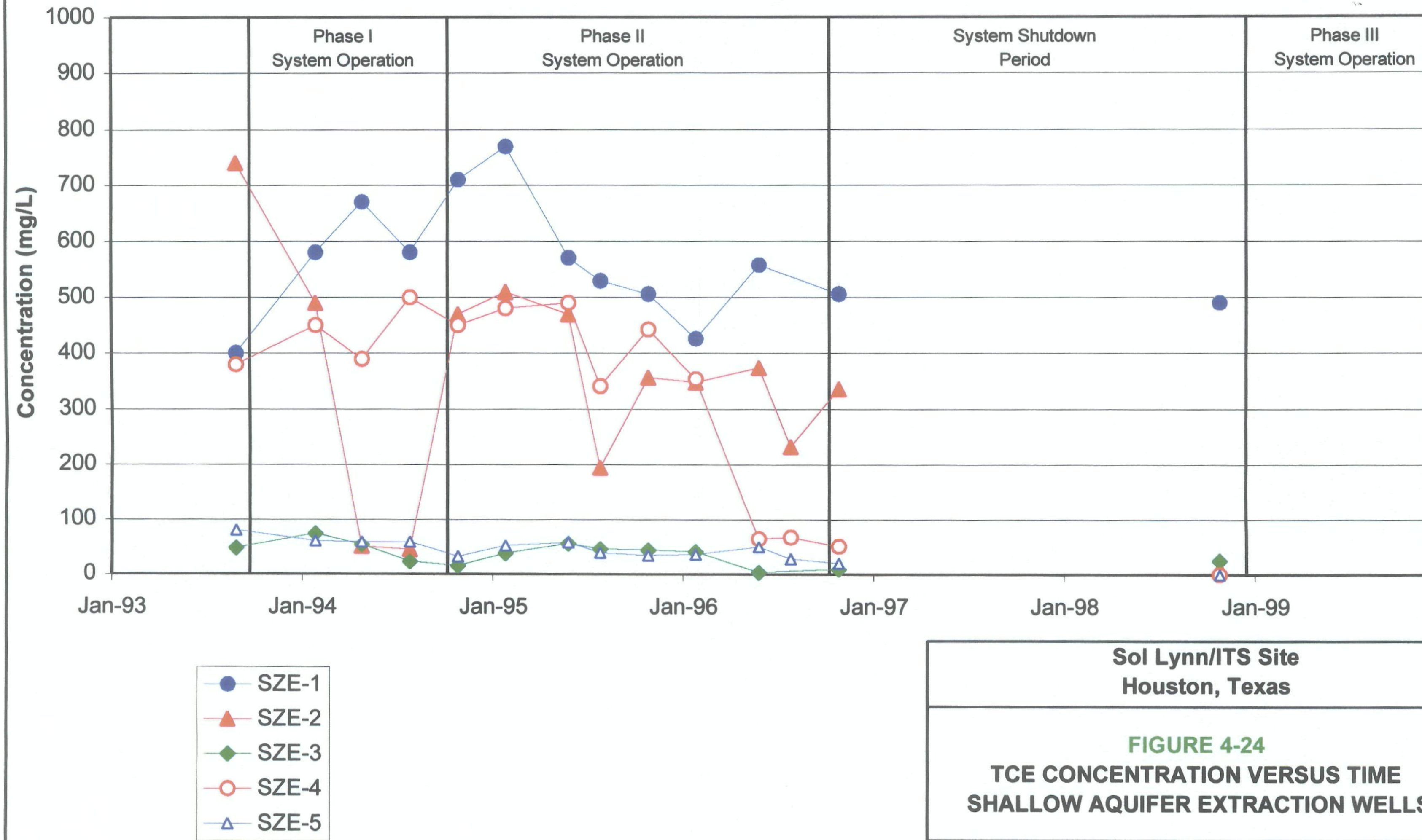


Sol Lynn/ITS Site
Houston, Texas

FIGURE 4-23

TCE CONCENTRATION VERSUS TIME
SHALLOW AQUIFER MONITORING WELL
MW-24

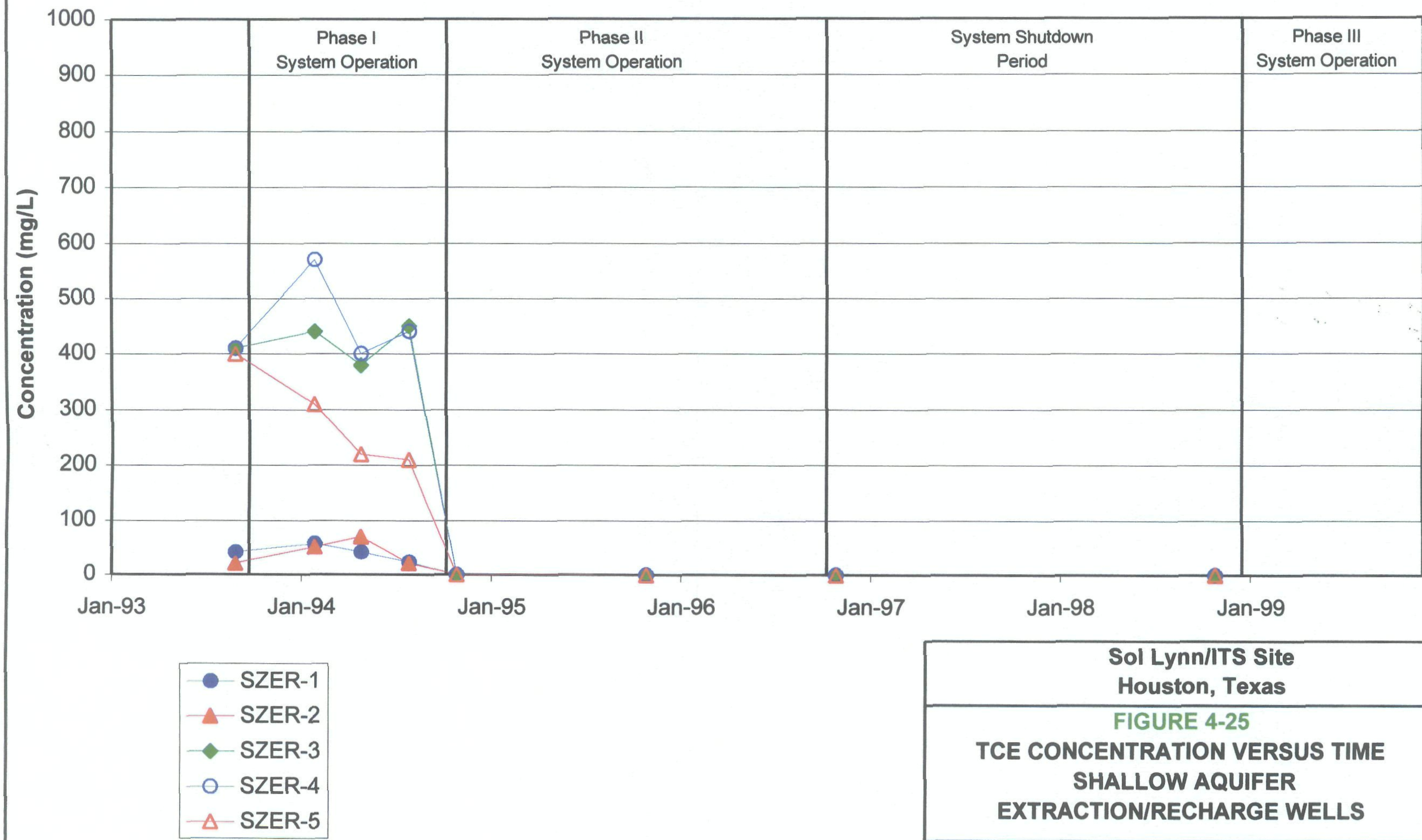
Tetra Tech EM Inc.



Sol Lynn/ITS Site
Houston, Texas

FIGURE 4-24
TCE CONCENTRATION VERSUS TIME
SHALLOW AQUIFER EXTRACTION WELLS

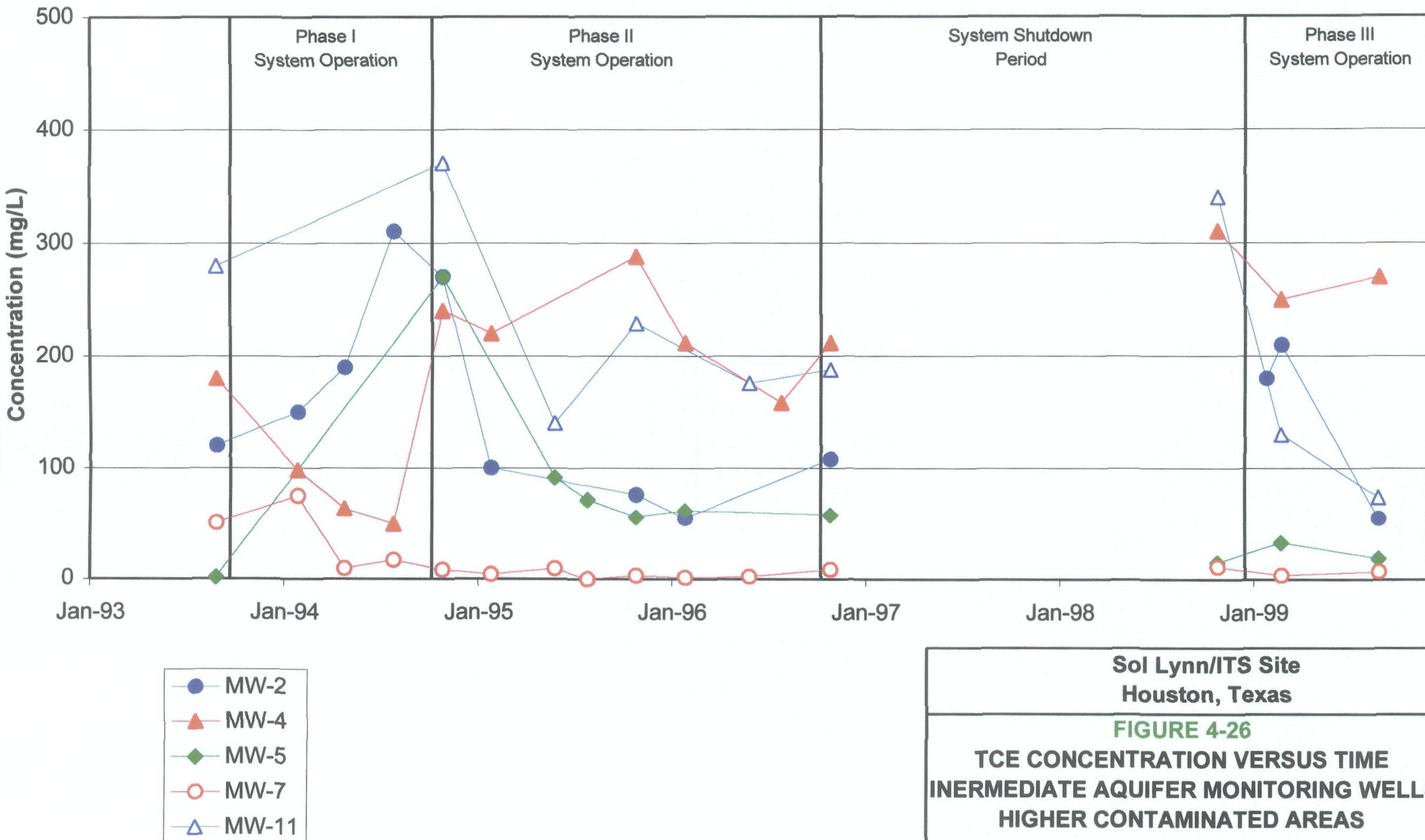
Tetra Tech EM Inc.



Sol Lynn/ITS Site
Houston, Texas

FIGURE 4-25
TCE CONCENTRATION VERSUS TIME
SHALLOW AQUIFER
EXTRACTION/RECHARGE WELLS

Tetra Tech EM Inc.

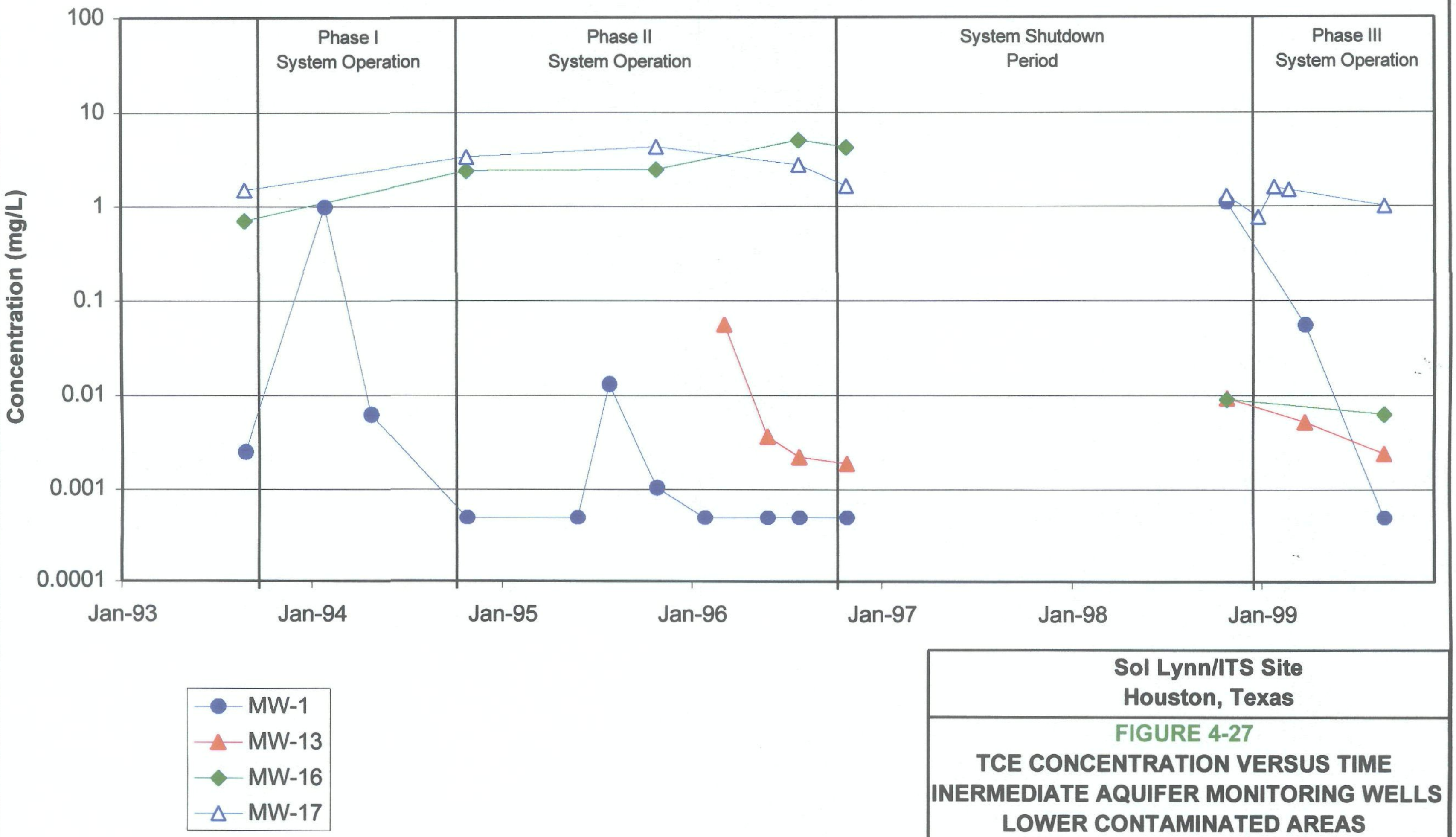


Sol Lynn/ITS Site
Houston, Texas

FIGURE 4-26

TCE CONCENTRATION VERSUS TIME
INERMEDIATE AQUIFER MONITORING WELLS
HIGHER CONTAMINATED AREAS

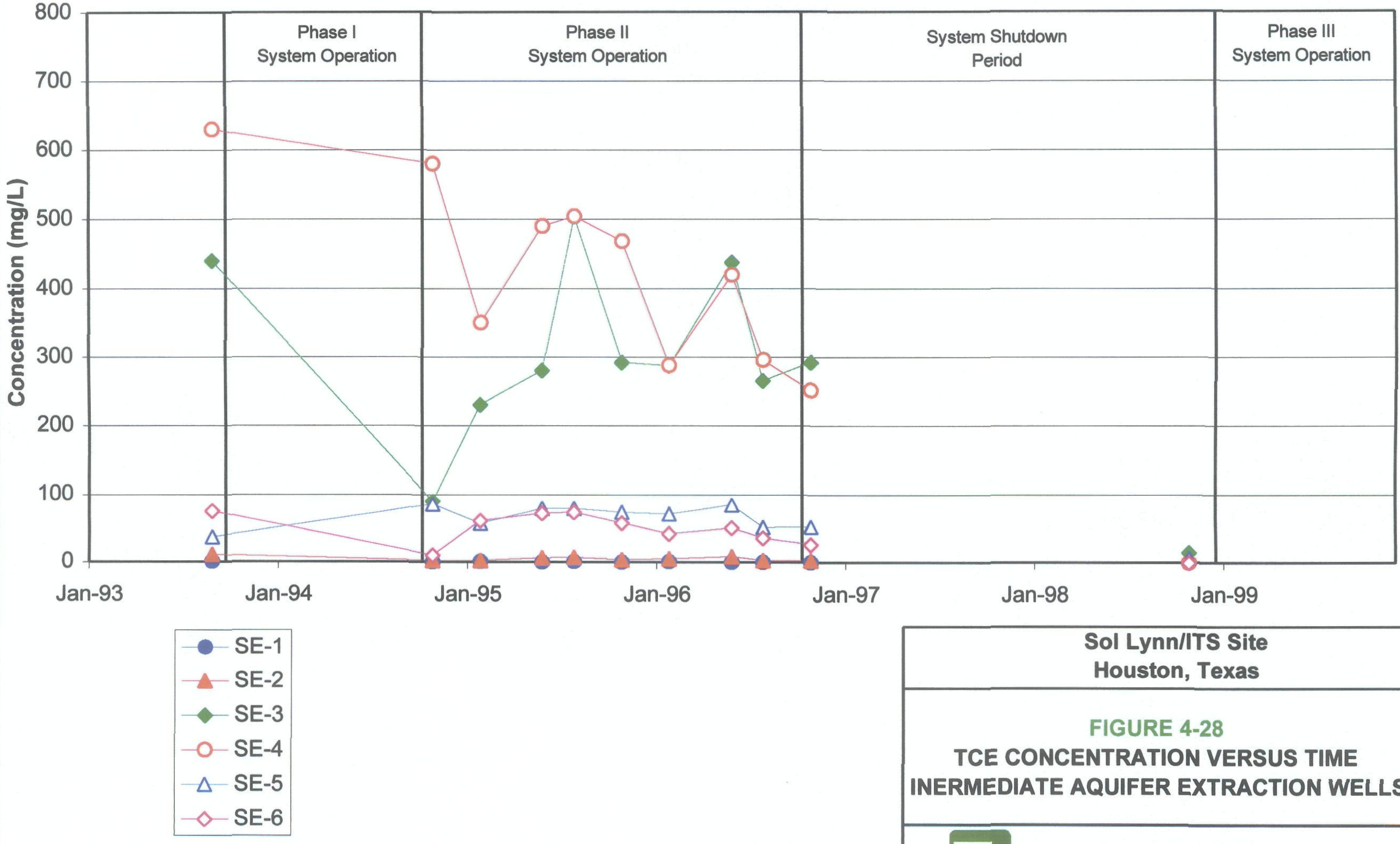
Tetra Tech EM Inc.



Sol Lynn/ITS Site
Houston, Texas

FIGURE 4-27
TCE CONCENTRATION VERSUS TIME
INERMEDIATE AQUIFER MONITORING WELLS
LOWER CONTAMINATED AREAS

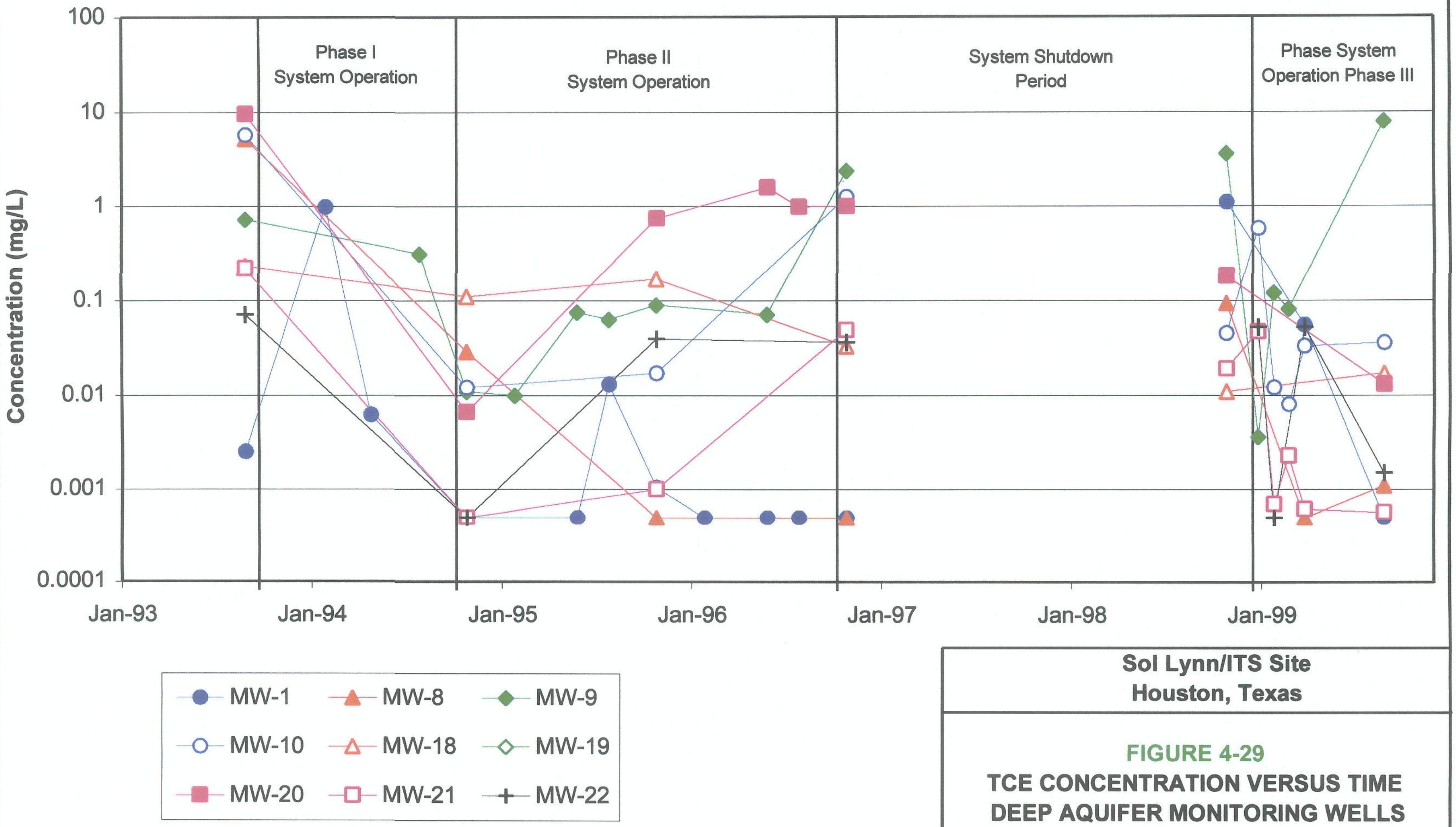
Tetra Tech EM Inc.



Sol Lynn/ITS Site
Houston, Texas

FIGURE 4-28
TCE CONCENTRATION VERSUS TIME
INERMEDIATE AQUIFER EXTRACTION WELLS

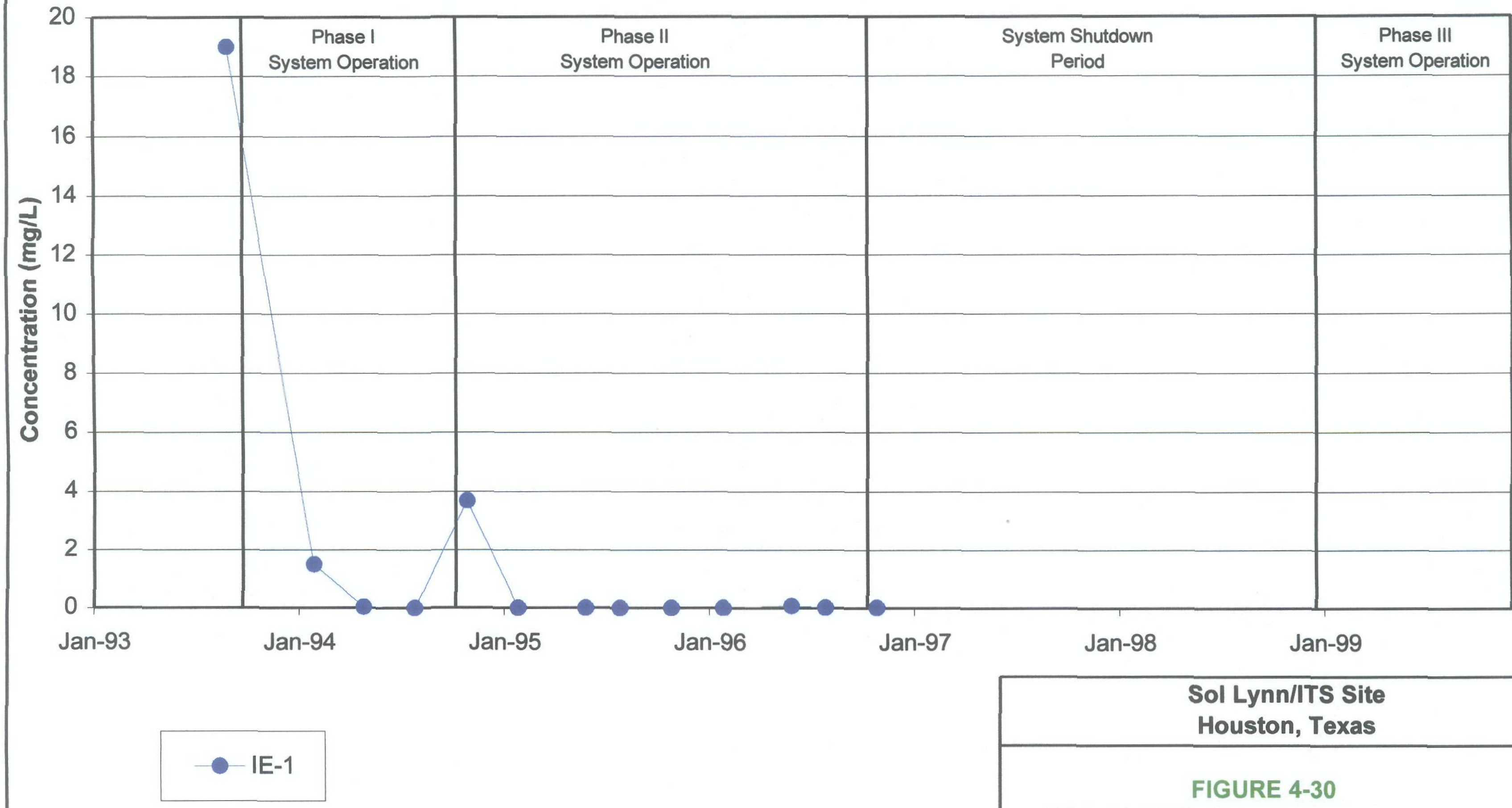
Tetra Tech EM Inc.



Sol Lynn/ITS Site
Houston, Texas

FIGURE 4-29
TCE CONCENTRATION VERSUS TIME
DEEP AQUIFER MONITORING WELLS

Tetra Tech EM Inc.



Sol Lynn/ITS Site
Houston, Texas

FIGURE 4-30
TCE CONCENTRATION VERSUS TIME
DEEP AQUIFER EXTRACTION WELL

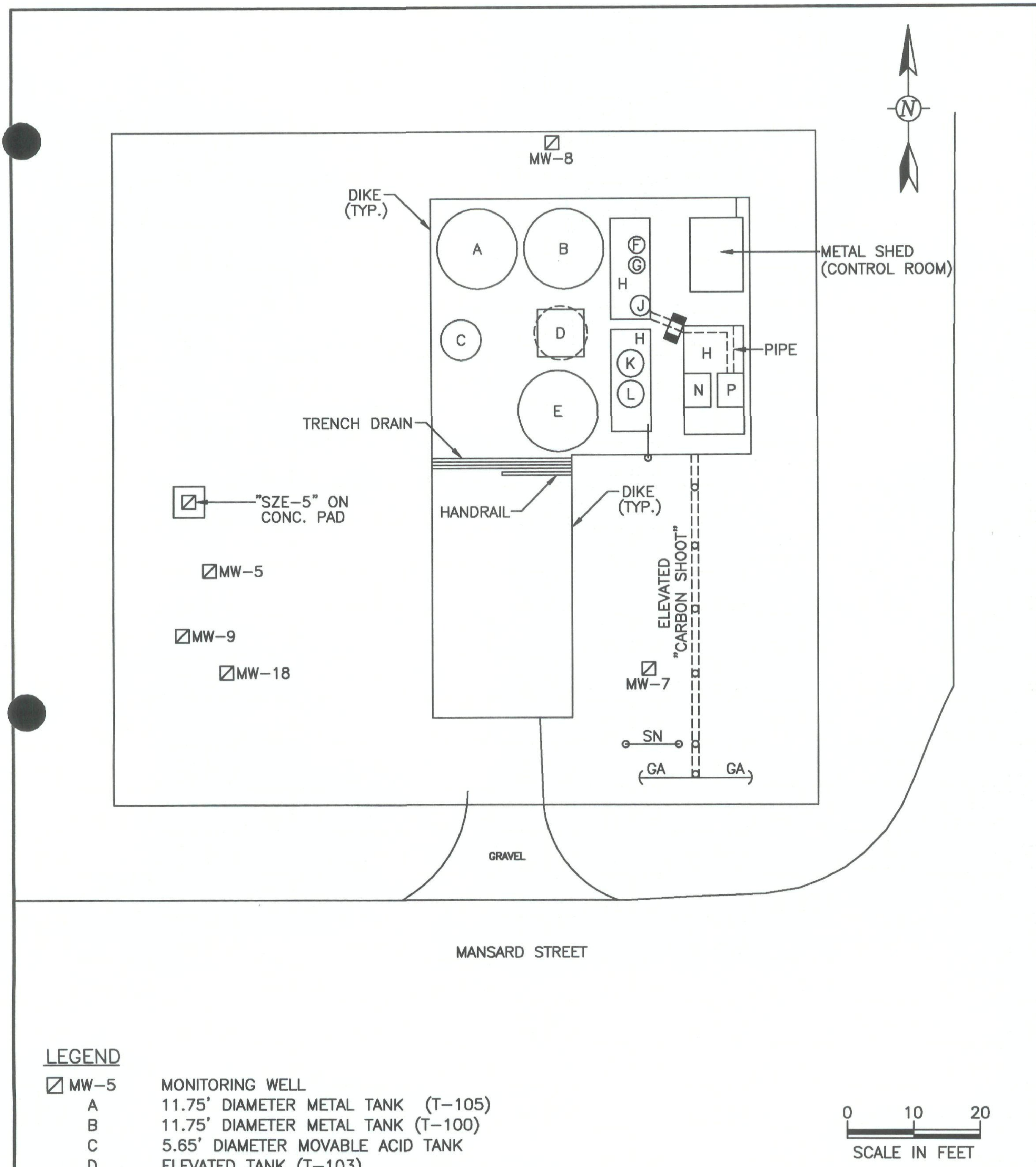
Tetra Tech EM Inc.

Source: Radian 1999

Sol Lynn/ITS Site
Houston, Texas

FIGURE 5-1
EXTRACTION AND RECHARGE WELL LOCATIONS AND GROUNDWATER EXTRACTION PIPING

Tetra Tech EM Inc.



LEGEND

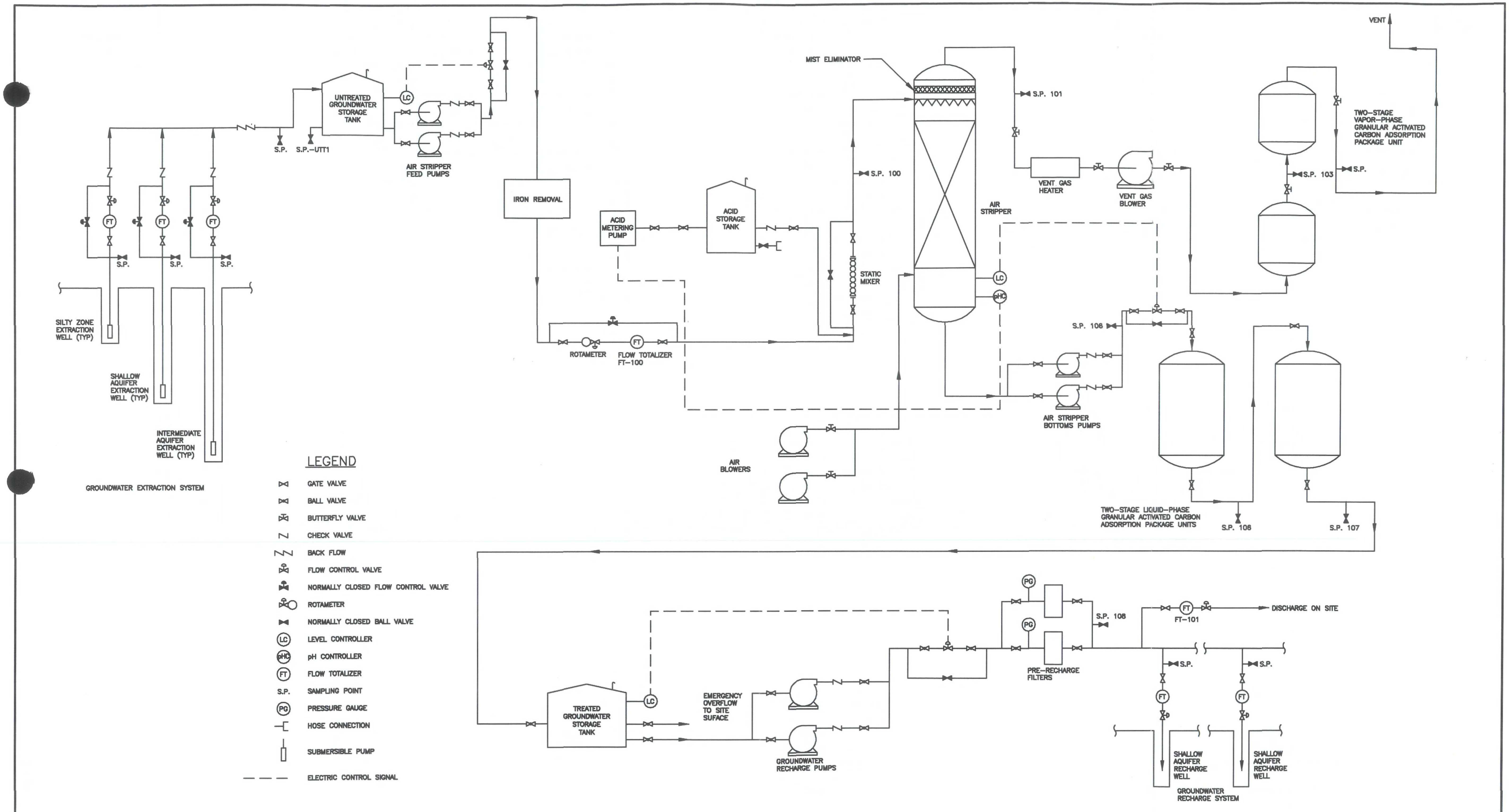
MW-5	MONITORING WELL
A	11.75' DIAMETER METAL TANK (T-105)
B	11.75' DIAMETER METAL TANK (T-100)
C	5.65' DIAMETER MOVABLE ACID TANK
D	ELEVATED TANK (T-103)
E	11.75' DIAMETER METAL TANK (T-102)
F	2.5' DIAMETER METAL TANK (LF-101A)
G	2.5' DIAMETER METAL TANK (LF-101B)
H	STEEL PAD/FLOORING
J	3.0' DIAMETER METAL TANK (AS-100)
K	4.5' DIAMETER METAL TANK (LF-100A)
L	4.5' DIAMETER METAL TANK (LF-100B)
M	MOVABLE METAL FOOTBRIDGE
N	METAL CARBON BED (VF-100B)
P	METAL CARBON BED (VF-100A)

Source: LAND TITLE SURVEY 1999

Sol Lynn/ITS Site
Houston, Texas

FIGURE 5-2
PLAN VIEW OF THE REMEDATION SYSTEM

Tetra Tech EM Inc.



Note: This process flow diagram provides conceptual level details only and may not include all process equipment, piping, and instrumentation components. Detailed design drawings shall be prepared by a qualified professional engineer registered in the State of Texas.

Sol Lynn/ITS Site
Houston, Texas

FIGURE 5-3
GROUND WATER TREATMENT SYSTEM
PROCESS FLOW DIAGRAM

Tetra Tech EM Inc.

Source: RADIAN CORPORATION NOV. 1996 STATUS REPORT

NOT TO SCALE

LEGEND

SZE-1 31.45 — EXTRACTION OR RECHARGE WELL NUMBER, GROUNDWATER ELEVATION ON NOV. 10, 1995 (FEET ABOVE MSL)

MW-24 35.49 — SHALLOW AQUIFER MONITORING WELL NUMBER, GROUNDWATER ELEVATION ON NOV. 10, 1995 (FEET ABOVE MSL)

35.0 — GROUNDWATER ELEVATION CONTOUR LINE (FEET ABOVE MSL)

OPERATIONAL EXTRACTION WELL IN SHALLOW AQUIFER

OPERATIONAL RECHARGE WELL IN SHALLOW AQUIFER

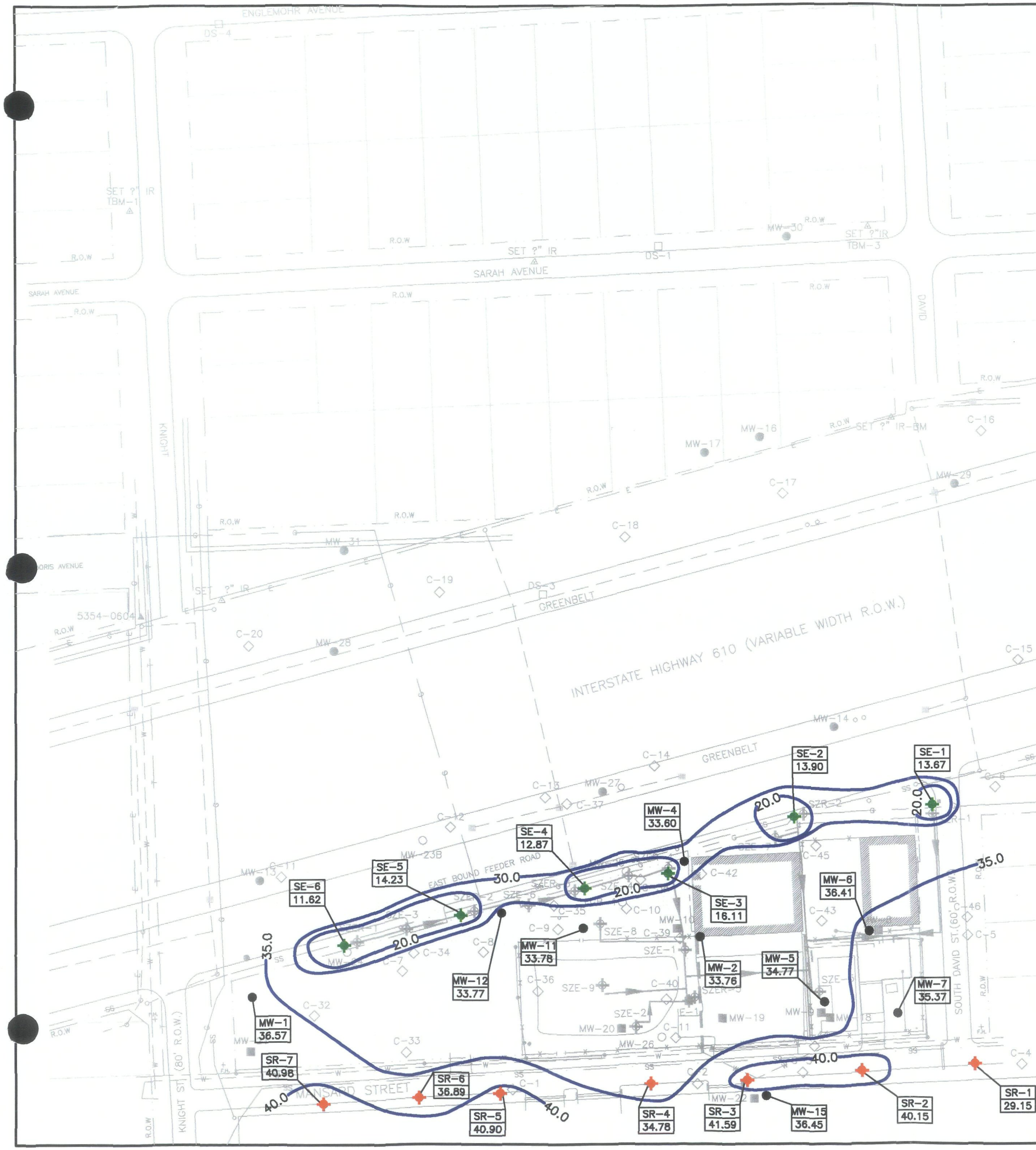
0 50 100
SCALE IN FEET

Source: Radian 1996

Sol Lynn/ITS Site
Houston, Texas

FIGURE 5-4
GROUNDWATER ELEVATION CONTOUR MAP
SHALLOW AQUIFER NOVEMBER 1995

Tetra Tech EM Inc.



N

LEGEND

SE-5 / 36.81	EXTRACTION OR RECHARGE WELL NUMBER GROUNDWATER ELEVATION ON NOV. 10, 1995 (FEET ABOVE MSL)
MW-11 / 33.78	INTERMEDIATE AQUIFER MONITORING WELL NUMBER GROUNDWATER ELEVATION ON NOV. 10, 1995 (FEET ABOVE MSL)
35.0	GROUNDWATER ELEVATION CONTOUR LINE (FEET ABOVE MSL)
	OPERATIONAL EXTRACTION WELL IN INTERMEDIATE AQUIFER
	OPERATIONAL RECHARGE WELL IN INTERMEDIATE AQUIFER

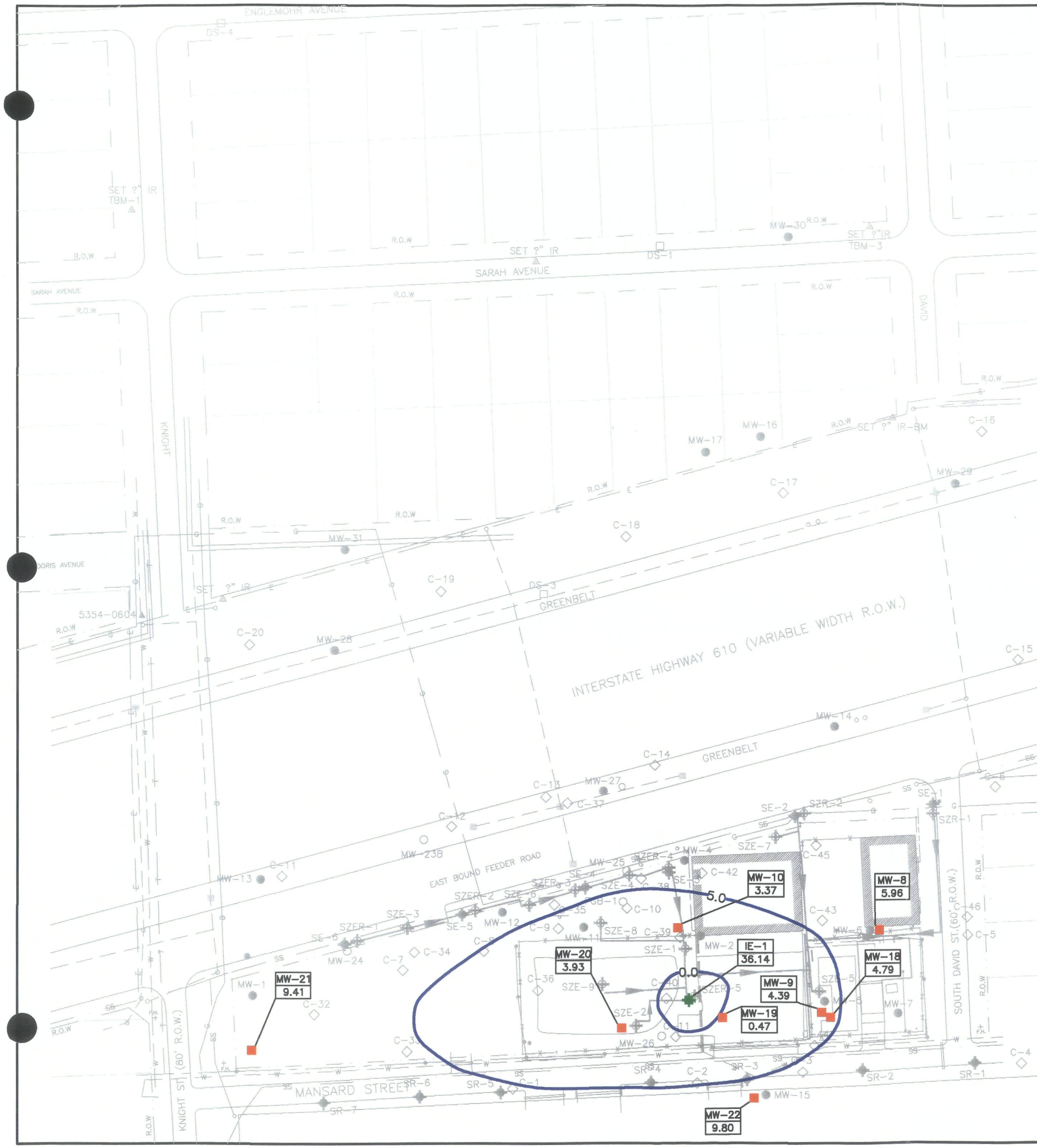
0 50 100
SCALE IN FEET

Source: Radian 1996

Sol Lynn/ITS Site
Houston, Texas

FIGURE 5-5
GROUNDWATER ELEVATION CONTOUR MAP
INTERMEDIATE AQUIFER NOVEMBER 1995

Tetra Tech EM Inc.



LEGEND

MW-21 9.41 — DEEP AQUIFER MONITORING WELL NUMBER GROUNDWATER ELEVATION ON NOV. 10, 1995 (FEET ABOVE MSL)

IE-1 36.14 — EXTRACTION OR RECHARGE WELL NUMBER GROUNDWATER ELEVATION ON NOV. 10, 1995 (FEET ABOVE MSL)

5.0 — GROUNDWATER ELEVATION CONTOUR LINE (FEET ABOVE MSL)

OPERATIONAL EXTRACTION WELL IN DEEP AQUIFER

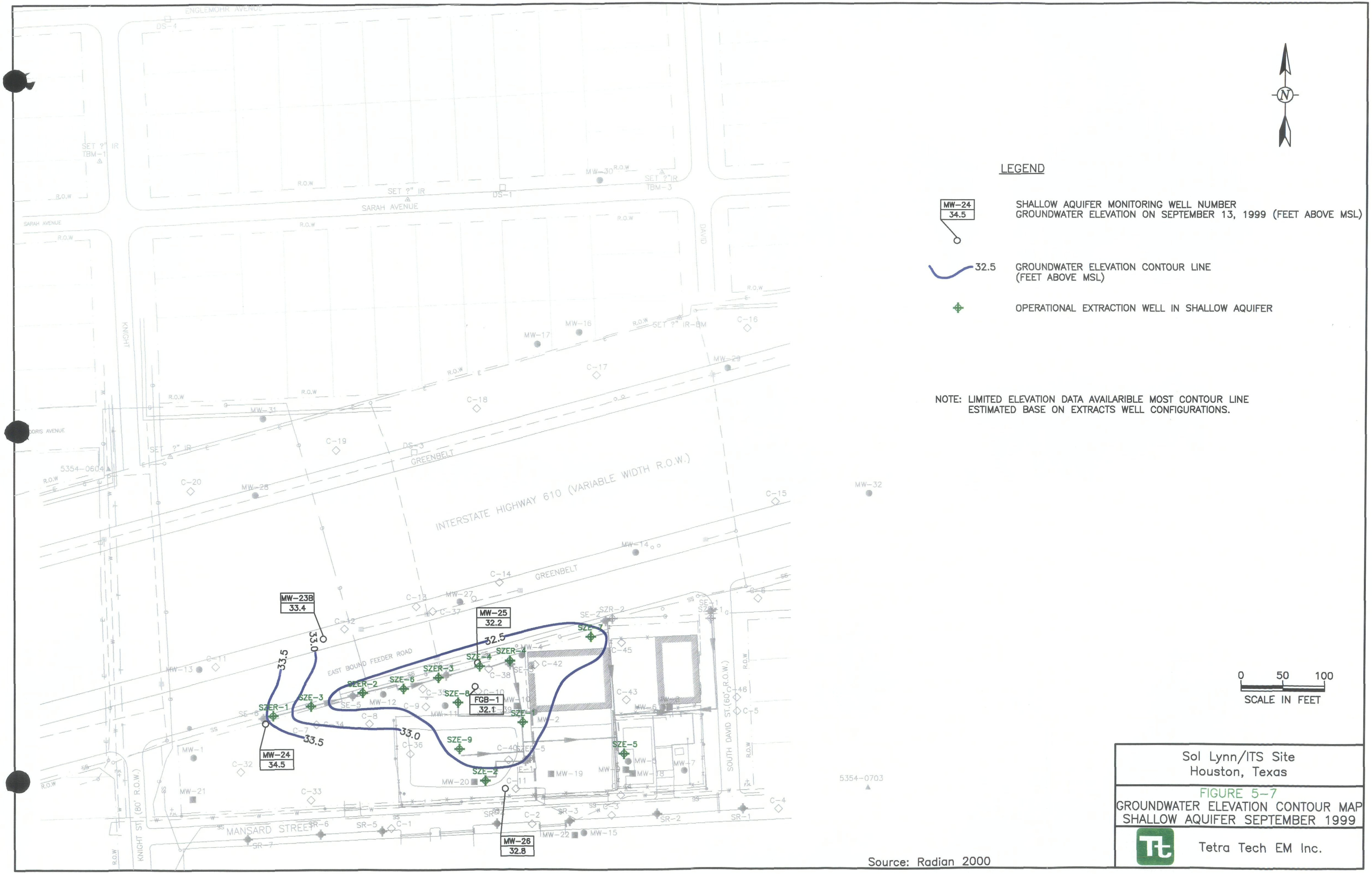
0 50 100
SCALE IN FEET

Source: Radian 1996

Sol Lynn/ITS Site
Houston, Texas

FIGURE 5-6
GROUNDWATER ELEVATION CONTOUR MAP
DEEP AQUIFER NOVEMBER 1995

Tetra Tech EM Inc.



Sol Lynn/ITS Site
Houston, Texas

FIGURE 5-7
GROUNDWATER ELEVATION CONTOUR MAP
SHALLOW AQUIFER SEPTEMBER 1999

Tetra Tech EM Inc.

LEGEND

MW-11 / 32 — INTERMEDIATE AQUIFER MONITORING WELL NUMBER GROUNDWATER ELEVATION ON SEPTEMBER 13, 1999 (FEET ABOVE MSL)

32.0 — GROUNDWATER ELEVATION CONTOUR LINE (FEET ABOVE MSL)

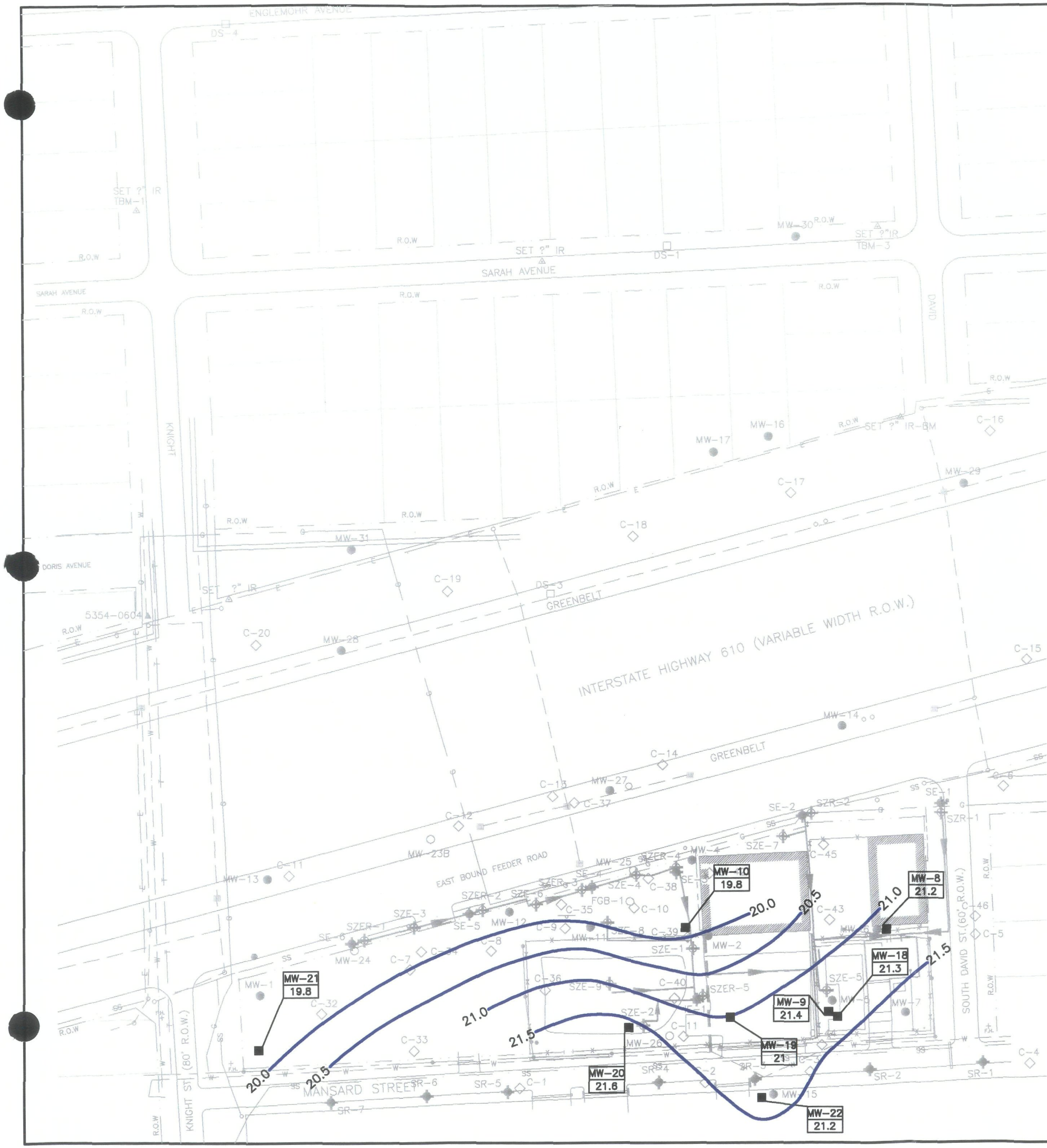
OPERATIONAL EXTRACTION WELL IN INTERMEDIATE AQUIFER

Source: Radian 2000

Sol Lynn/ITS Site
Houston, Texas

FIGURE 5-8
GROUNDWATER ELEVATION CONTOUR MAP
INTERMEDIATE AQUIFER SEPTEMBER 1999

Tetra Tech EM Inc.



N

LEGEND

MW-21 19.8	DEEP AQUIFER MONITORING WELL NUMBER GROUNDWATER ELEVATION ON SEPTEMBER 13, 1999 (FEET ABOVE MSL)
20.0	GROUNDWATER ELEVATION CONTOUR LINE (FEET ABOVE MSL)

NOTE: DEEP AQUIFER EXTRACTION WELL WAS OPERATIONAL AT TIME OF MEASUREMENT.

0 50 100
SCALE IN FEET

Source: Radian 2000

Sol Lynn/ITS Site
Houston, Texas

FIGURE 5–9
GROUNDWATER ELEVATION CONTOUR MAP
DEEP AQUIFER SEPTEMBER 1999

Tetra Tech EM Inc.

APPENDIX

The EDR-Radius Map
with GeoCheck®

Sol Lynn
1419 South Loop West
Houston, TX 77054

Inquiry Number: 464973.1s

February 21, 2000

Environmental Data Resources, Inc.
an edr company

The Source
For Environmental
Risk Management
Data

3530 Post Road
Southport, Connecticut 06490

Nationwide Customer Service

Telephone: 1-800-352-0050
Fax: 1-800-231-6802
Internet: www.edrnet.com

TABLE OF CONTENTS

Thank you for your business.
Please contact EDR at 1-800-352-0050
with any questions or comments.

EXECUTIVE SUMMARY

A search of available environmental records was conducted by Environmental Data Resources, Inc. (EDR). The report meets the government records search requirements of ASTM Standard Practice for Environmental Site Assessments, E 1527-97. Search distances are per ASTM standard or custom distances requested by the user.

TARGET PROPERTY ADDRESS

1419 SOUTH LOOP WEST
HOUSTON, TX 77054

TARGET PROPERTY COORDINATES

Latitude (North):	29.678900 - 29˚ 40' 44.0"
Longitude (West):	95.398500 - 95˚ 23' 54.6"
Universal Tranverse Mercator:	Zone 15
UTM X (Meters):	267889.7
UTM Y (Meters):	3285433.5

USGS TOPOGRAPHIC MAP ASSOCIATED WITH TARGET PROPERTY

Target Property: 2429095-F4 BELLAIRE, TX
Source: USGS 7.5 min quad index

TARGET PROPERTY SEARCH RESULTS
The target property was identified in the following government records. For more information on this property see page 11 of the attached EDR Radius Map report:

Site	Database(s)	EPA ID
SOL LYNN/INDUSTRIAL TRANSFORMERS 1415, 1417, 1419 S LOOP WEST HOUSTON, TX 77054	CERCLIS FINDS NPL CONSENT ROD	TXD980873327

SURROUNDING SITES: DATABASES WITH NO MAPPED SITES

No mapped sites were found in EDR's search of available ("reasonably ascertainable ") government records either on the target property or within the ASTM E 1527-97 search radius around the target property for the following Databases:

FEDERAL ASTM STANDARD

Delisted NPL:.................. NPL Deletions
CERC-NFRAP:................. Comprehensive Environmental Response, Compensation, and Liability Information System
RCRIS-TSD:.................... Resource Conservation and Recovery Information System
ERNS:............................ Emergency Response Notification System

STATE ASTM STANDARD

SHWS:............................ State Haz. Waste
CLI:................................ MSW Closed and Abandoned Landfills

FEDERAL ASTM SUPPLEMENTAL

HMIRS:.......................... Hazardous Materials Information Reporting System

EXECUTIVE SUMMARY

MLTS:........................ Material Licensing Tracking System
MINES:........................ Mines Master Index File
NPL Lien:.................... NPL Liens
PADS:........................ PCB Activity Database System
RAATS:...................... RCRA Administrative Action Tracking System
TRIS:........................ Toxic Chemical Release Inventory System
TSCA:........................ Toxic Substances Control Act

STATE OR LOCAL ASTM SUPPLEMENTAL

AST:......................... Petroleum Storage Tank Database
TX Spills:.................... TX Spills
TX VCP:...................... Texas Natural Resource Conservation Commission
TX MM:....................... Multi Media Enforcement Cases
TX IHW:...................... Industrial & Hazardous Waster Database
WasteMgt:................... WasteMgt
AIRS:........................ Aerometric Information Retrieval System Facility Subsystem

EDR PROPRIETARY DATABASES

Coal Gas:.................... Former Manufactured gas (Coal Gas) Sites.

SURROUNDING SITES: DATABASES WITH MAPPED SITES

Unmapped (orphan) sites are not considered in the foregoing analysis.

Elevations have been determined from the USGS 1 degree Digital Elevation Model and should be evaluated on a relative (not an absolute) basis. Relative elevation information between sites of close proximity should be field verified. EDR's definition of a site with an elevation equal to the target property includes a tolerance of +/- 10 feet. Sites with an elevation equal to or higher than the target property have been differentiated below from sites with an elevation lower than the target property (by more than 10 feet). Page numbers and map identification numbers refer to the EDR Radius Map report where detailed data on individual sites can be reviewed.

Sites listed in ***bold italics*** are in multiple databases.

FEDERAL ASTM STANDARD

CORRACTS: CORRACTS is a list of handlers with RCRA Corrective Action Activity. This report shows which nationally-defined corrective action core events have occurred for every handler that has had corrective action activity.

A review of the CORRACTS list, as provided by EDR, and dated 09/07/1999 has revealed that there are 2 CORRACTS sites within approximately 1 mile of the target property.

Equal/Higher Elevation	Address	Dist / Dir	Map ID	Page
COOK COMPOSITES & POLYMERS	***2434 HOLMES RD***	***1/2 - 1 SSE***	***C20***	***25***
MAGNA CORPORATION - HOUSTON	***2434 HOLMES RD***	***1/2 - 1 SSE***	***C21***	***26***

EXECUTIVE SUMMARY

RCRIS: The Resource Conservation and Recovery Act database includes selected information on sites that generate, store, treat, or dispose of hazardous waste as defined by the Act. The source of this database is the U.S. EPA.

A review of the RCRIS-LQG list, as provided by EDR, and dated 09/01/1999 has revealed that there is 1 RCRIS-LQG site within approximately 0.25 miles of the target property.

Equal/Higher Elevation	Address	Dist / Dir	Map ID	Page
INDUSTIAL TRANSPORMER SPRFUND	*8921 DAVID ST*	*0 - 1/8 ESE*	*3*	*15*

RCRIS: The Resource Conservation and Recovery Act database includes selected information on sites that generate, store, treat, or dispose of hazardous waste as defined by the Act. The source of this database is the U.S. EPA.

A review of the RCRIS-SQG list, as provided by EDR, and dated 09/01/1999 has revealed that there are 3 RCRIS-SQG sites within approximately 0.25 miles of the target property.

Equal/Higher Elevation	Address	Dist / Dir	Map ID	Page
SOUTHWESTERN BELL TEL CO	***2032 MANSARD***	***0 - 1/8 SW***	***2***	***14***
SERVICE IND OF AM	***8703 KNIGHT RD***	***0 - 1/8 W***	***4***	***15***
CUNNINGHAM AUTO	***8600 KNIGHT RD***	***1/8 - 1/4 NNW***	***5***	***15***

STATE ASTM STANDARD

SWF/LF: The Solid Waste Facilities/Landfill Sites records typically contain an inventory of solid waste disposal facilities or landfills in a particular state. The data come from the Texas Natural Resource Conservation Commission's permitted Solid Waste Facilities list.

A review of the SWF/LF list, as provided by EDR, and dated 12/01/1999 has revealed that there is 1 SWF/LF site within approximately 0.5 miles of the target property.

Equal/Higher Elevation	Address	Dist / Dir	Map ID	Page
Not reported	HOUSTON KNIGHT RD BTWN	1/4 - 1/2 SE	13	21

LUST: The Leaking Underground Storage Tank Incident Reports contain an inventory of reported leaking underground storage tank incidents. The data come from the Texas Natural Resource Conservation Commission's Leaking Petroleum Storage Tank Database.

A review of the LUST list, as provided by EDR, and dated 10/01/1999 has revealed that there are 11 LUST sites within approximately 0.5 miles of the target property.

Equal/Higher Elevation	Address	Dist / Dir	Map ID	Page
ALL PAN INC	1107 SOUTH LOOP W	1/8 - 1/4 ENE	A7	17
SOUTH LOOP FORD TRUCK SALES, I	8901 ALMEDA RD	1/4 - 1/2 ESE	9	20
ALMEDA BUILDING	8821 ALMEDA RD	1/4 - 1/2 E	10	20
AACI - WOODWORK DIVISION	9011 E ALMEDA ST	1/4 - 1/2 ESE	11	20
SHEPLER EQUIPMENT	9103 E ALMEDA ST	1/4 - 1/2 ESE	12	21
TEXACO STATION	8610 ALMEDA RD	1/4 - 1/2 ENE	14	22
CHEVRON FAC #108194	8550 ALMEDA RD	1/4 - 1/2 ENE	15	23
STATE INSPECTION PLUS	8551 ALMEDA RD	1/4 - 1/2 ENE	16	23
FEDERAL SIGN CO	***8315 KNIGHT RD***	***1/4 - 1/2 N***	***B17***	***24***

Equal/Higher Elevation	Address	Dist / Dir	Map ID	Page
STOP-N-GO MARKET (490)	8301 KNIGHT RD	1/4 - 1/2 N	B18	24
Not reported	1800 SOUTH LOOP W # 610	1/4 - 1/2 W	19	25

UST: The Underground Storage Tank database contains registered USTs. USTs are regulated under Subtitle I of the Resource Conservation and Recovery Act (RCRA). The data come from the Texas Natural Resource Conservation Commission's Petroleum Storage Tank Database.

A review of the UST list, as provided by EDR, and dated 10/01/1999 has revealed that there are 3 UST sites within approximately 0.25 miles of the target property.

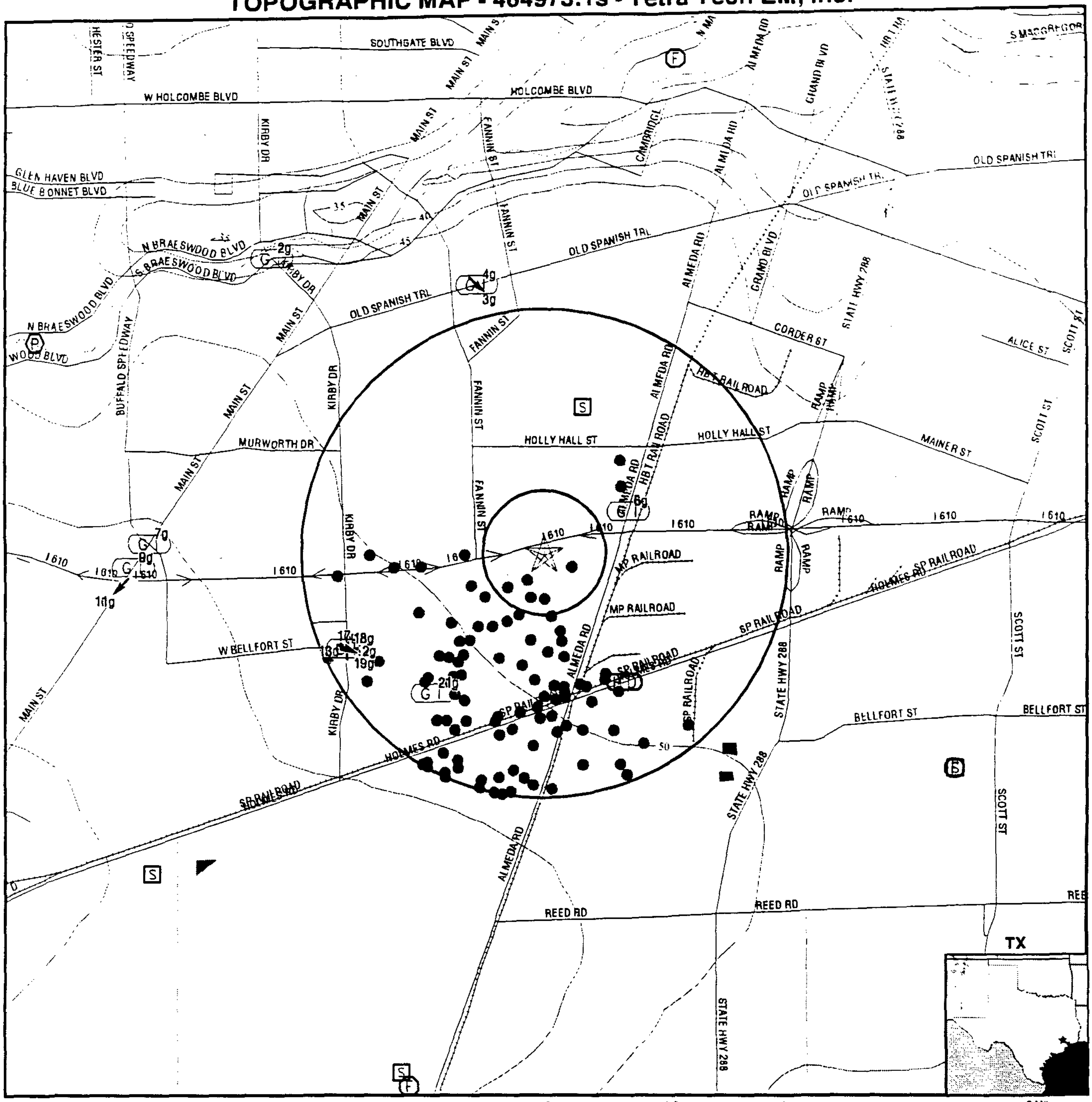
Equal/Higher Elevation	Address	Dist / Dir	Map ID	Page
INTERNATIONAL TOOL & SUPPLY CO	***825 SOUTH LOOP W***	***0 - 1/8 N***	***1***	***13***
ASTRODOME CONOCO	1522 SOUTH LOOP W	1/8 - 1/4 W	6	16
ALL PAN, INC	1107 SOUTH LOOP W	1/8 - 1/4 ENE	A8	18

EXECUTIVE SUMMARY

Due to poor or inadequate address information, the following sites were not mapped:

Site Name	Database(s)
FEDERATED METALS	SHWS
WASTE OIL TANK SERVICE	SHWS
LA PATA OIL	SHWS
500'E OF IH610,S OF PORT TERMI	SWF/LF
W SIDE OF FM-521, 3-1/2MI N OF	SWF/LF
CHEVRON #60-108129	LUST
FORMER MOBIL SS #12-409	LUST
DIAMOND SHAMROCK #260	LUST
AAMCO TRANSMISSIONS	RCRIS-SQG, FINDS, TX IHW
MIKE CALVERT TOYOTA BODY SHOP	RCRIS-SQG, FINDS
GILLESPIE PETROLEUM INC	RCRIS-SQG, FINDS
FORMER WAUKESHA-PEARCE INDUSTRIES	TX VCP

TOPOGRAPHIC MAP - 464973.1s - Tetra Tech EM, Inc.



Major Roads
Contour Lines
Waterways
Earthquake epicenter, Richter 5 or greater
Closest Federal Well in quadrant
Closest State Well in quadrant
Closest Public Water Supply Well
Closest Hydrogeological Data
Oil or gas wells (in certain Texas counties)
Groundwater Flow Direction
(G I) Indeterminate Groundwater Flow at Location
(G V) Groundwater Flow Varies at Location

TARGET PROPERTY:	Sol Lynn	CUSTOMER:	Tetra Tech EM, Inc.
ADDRESS:	1419 South Loop West	CONTACT:	Jen Seidel
CITY/STATE/ZIP:	Houston TX 77054	INQUIRY #:	464973.1s
LAT/LONG:	29.6789 / 95.3985	DATE:	February 21, 2000 8:12 am

GEOCHECK VERSION 2.1
SUMMARY

TARGET PROPERTY COORDINATES

Latitude (North):	29.678900 - 29˚ 40' 44.0"
Longitude (West):	95.398499 - 95˚ 23' 54.6"
Universal Transverse Mercator:	Zone 15
UTM X (Meters):	267889.7
UTM Y (Meters):	3285433.5

USGS TOPOGRAPHIC MAP ASSOCIATED WITH THIS SITE

Target Property:	2429095-F4 BELLAIRE, TX

GEOLOGIC AGE IDENTIFICATION†

Geologic Code:	Qp
Era:	Cenozoic
System:	Quaternary
Series:	Pleistocene

ROCK STRATIGRAPHIC UNIT†

Category:	Stratifed Sequence

GROUNDWATER FLOW INFORMATION

Groundwater flow direction for a particular site is best determined by a qualified environmental professional using site-specific well data. If such data is not reasonably ascertainable, it may be necessary to rely on other sources of information, including well data collected on nearby properties, regional groundwater flow information (from deep aquifers), or surface topography.‡

AQUIFLOW™** Search Radius: 2.000 Miles. The following table shows sites where groundwater flow and depth information was reported. Additional AQUIFLOW™ site information may be available in the GeoCheck® section at the end of this report.

MAP ID	DISTANCE FROM TP	DIRECTION FROM TP	GENERAL DIRECTION GROUNDWATER FLOW
3g	1 - 2 Miles	NNW	SE
4g	1 - 2 Miles	NNW	NOT REPORTED
5g	1/4 - 1/2 Mile	ENE	VARIES
6g	1/4 - 1/2 Mile	ENE	VARIES
7g	1 - 2 Miles	West	NOT REPORTED
8g	1 - 2 Miles	West	Not Reported
10g	1 - 2 Miles	West	SW
11g	1 - 2 Miles	West	SW
13g	1/2 - 1 Mile	WSW	W
15g	1/2 - 1 Mile	WSW	N
16g	1/2 - 1 Mile	WSW	N
17g	1/2 - 1 Mile	WSW	N
19g	1/2 - 1 Mile	WSW	ESE
20g	1/2 - 1 Mile	SW	VARIES
21g	1/2 - 1 Mile	SW	Not Reported

For additional site information, refer to GeoCheck Appendix.

† Source: P.G. Schruben, R.E. Arndt and W.J. Bawiec, Geology of the Conterminous U.S. at 1:2,500,000 Scale - A digital representation of the 1974 P.B. King and H.M. Beikman Map, USGS Digital Data Series DDS - 11 (1994).
‡ U.S. EPA Ground Water Handbook, Vol I: Ground Water and Contamination, Office of Research and development EPA/625/6-90/016a,Chapter 4, page 78, September 1990.
** EDR AQUIFLOW™ information System of hydrogeologically determined groundwater flow directions at specific locations. See the data pages at the end of this report for a complete description.

GEOCHECK VERSION 2.1
SUMMARY

General Topographic Gradient at Target Property: Undeterminable
General Hydrogeologic Gradient at Target Property: The hydrogeologic gradient for this report has been determined using the depth to water table information provided below. Where available, the closest well in each quadrant has been identified (up to a radius of 5 miles around the target property) and used in the gradient calculation. While an attempt has been made to segregate shallow from deep aquifers, this cannot always be assured. Groundwater flow in the aquifer associated with the wells appears generally to be to the NE. This would appear to be in conflict with the topographical gradient. The direction of the groundwater flow should be determined by a qualified environmental professional.

Site-Specific Hydrogeological Data*:

Search Radius:	2.0 miles
Location Relative to TP:	1/2 - 1 Mile SSE
Site Name:	MAGNA CORPORATION - HOUSTON
Site EPA ID Number:	TXD000807875
Groundwater Flow Direction:	South
Inferred Depth to Water:	20 to 25 feet.
Hydraulic Connection:	Detailed hydraulic connection information is not available. Soil permeability at the site is considered very low. The Beaumont formation interbedded sands and dense clay underlies the site.
Sole Source Aquifer:	No information about a sole source aquifer is available
Data Quality:	Information is inferred in the CERCLIS investigation report(s)

FEDERAL DATABASE WELL INFORMATION

WELL QUADRANT	DISTANCE FROM TP	LITHOLOGY	DEPTH TO WATER TABLE
Northern	>2 Miles	Not Reported	327 ft.
Eastern	1 - 2 Miles	Not Reported	260 ft.
Southern	>2 Miles	Not Reported	Not Reported
Western	>2 Miles	Not Reported	208 ft.

STATE WATER WELL INFORMATION

DIRECTION FROM TP	DISTANCE FROM TP	DEPTH FEET	SOURCE
Northern	1/2 - 1 Mile	432	Texas Water Development Board
Eastern	1 - 2 Miles	1225	Texas Water Development Board
Southern	>2 Miles	455	Texas Water Development Board
Western	>2 Miles	301	Texas Water Development Board

STATE OIL/GAS WELL INFORMATION

WELL #	DISTANCE FROM TP (Miles)	WELL #	DISTANCE FROM TP (Miles)
		42201	1/4 - 1/2 Mile NE
42201	1/4 - 1/2 Mile NE	42201 D1	1/2 - 1 Mile West
42201	1/4 - 1/2 Mile West	42201	1/2 - 1 Mile West
42201	1/2 - 1 Mile West	42201	1/8 - 1/4 Mile ESE
42201	1/2 - 1 Mile West	42201	1/8 - 1/4 Mile SSW
4220104854	1/4 - 1/2 Mile WSW	4220104855	1/8 - 1/4 Mile SW
42201	1/4 - 1/2 Mile SW	42201	1/8 - 1/4 Mile SSW
42201	1/8 - 1/4 Mile South	42201	1/2 - 1 Mile WSW
42201 D1	1/4 - 1/2 Mile SSW	42201	1/4 - 1/2 Mile South
42201	1/4 - 1/2 Mile SSW	42201	1/4 - 1/2 Mile SW
42201	1/4 - 1/2 Mile SW	42201	1/4 - 1/2 Mile SW
42201	1/4 - 1/2 Mile SSE	42201	1/2 - 1 Mile WSW
42201	1/4 - 1/2 Mile SW	42201	1/4 - 1/2 Mile South

GEOCHECK VERSION 2.1
SUMMARY

STATE OIL/GAS WELL INFORMATION

WELL #	DISTANCE FROM TP (Miles)	WELL #	DISTANCE FROM TP (Miles)
42201	1/2 - 1 Mile SW	42201	1/4 - 1/2 Mile SSE
42201	1/4 - 1/2 Mile South	42201	1/2 - 1 Mile SW
4220181380	1/2 - 1 Mile SW	42201	1/2 - 1 Mile SW
42201	1/4 - 1/2 Mile South	4220104848	1/2 - 1 Mile WSW
4220104865	1/4 - 1/2 Mile SSW	42201	1/2 - 1 Mile WSW
42201	1/2 - 1 Mile SW	42201	1/4 - 1/2 Mile South
42201	1/2 - 1 Mile SSE	42201 D1	1/2 - 1 Mile SW
42201	1/2 - 1 Mile SW	42201	1/2 - 1 Mile SW
42201	1/2 - 1 Mile South	42201	1/2 - 1 Mile SSE
42201	1/2 - 1 Mile SW	42201	1/2 - 1 Mile SW
42201	1/2 - 1 Mile SSE	42201	1/2 - 1 Mile South
42201	1/2 - 1 Mile SSE	42201	1/2 - 1 Mile South
4220105220D1	1/2 - 1 Mile SSE	42201	1/2 - 1 Mile South
42201	1/2 - 1 Mile SSW	42201	1/2 - 1 Mile South
42201	1/2 - 1 Mile South	4220104859	1/2 - 1 Mile SSW
42201	1/2 - 1 Mile South	4220105227D1	1/2 - 1 Mile SSE
42201	1/2 - 1 Mile South	42201	1/2 - 1 Mile South
42201	1/2 - 1 Mile South	42201	1/2 - 1 Mile SSW
42201	1/2 - 1 Mile South	42201	1/2 - 1 Mile SSW
42201	1/2 - 1 Mile SSW	42201	1/2 - 1 Mile SSW
42201	1/2 - 1 Mile SSW	42201	1/2 - 1 Mile SE
4220181373	1/2 - 1 Mile South	42201	1/2 - 1 Mile South
42201	1/2 - 1 Mile SSW	4220181377	1/2 - 1 Mile SSE
42201	1/2 - 1 Mile SSE	42201	1/2 - 1 Mile South
42201	1/2 - 1 Mile SSW	4220105219D1	1/2 - 1 Mile SSE
42201	1/2 - 1 Mile South	42201	1/2 - 1 Mile SSW
42201	1/2 - 1 Mile SSW	42201	1/2 - 1 Mile SSW
42201	1/2 - 1 Mile SSW	4220181374	1/2 - 1 Mile SSE
4220105232	1/2 - 1 Mile South	42201	1/2 - 1 Mile SSW
42201	1/2 - 1 Mile SSW	42201	1/2 - 1 Mile South
42201	1/2 - 1 Mile SSW	42201	1/2 - 1 Mile SSE
4220104937	1/2 - 1 Mile SSW	4220130031	1/2 - 1 Mile SSW
42201	1/2 - 1 Mile South	4220181384	1/2 - 1 Mile SSW
4220104988	1/2 - 1 Mile South	42201	1/2 - 1 Mile SSW
42201	1/2 - 1 Mile South	4220104987	1/2 - 1 Mile South
42201	1/2 - 1 Mile SSW	4220181744	1/2 - 1 Mile South

PUBLIC WATER SUPPLY SYSTEM INFORMATION

Searched by Nearest PWS.
NOTE: PWS System location is not always the same as well location.

PWS Name: L R MHP
4131 DURNESS
HOUSTON, TX 77025
Location Relative to TP: >2 Miles West
PWS currently has or has had major violation(s) or enforcement: No

AREA RADON INFORMATION

EPA Radon Zone for HARRIS County: 3

Note: Zone 1 indoor average level > 4 pCi/L.
: Zone 2 indoor average level >= 2 pCi/L and <= 4 pCi/L.
: Zone 3 indoor average level < 2 pCi/L.

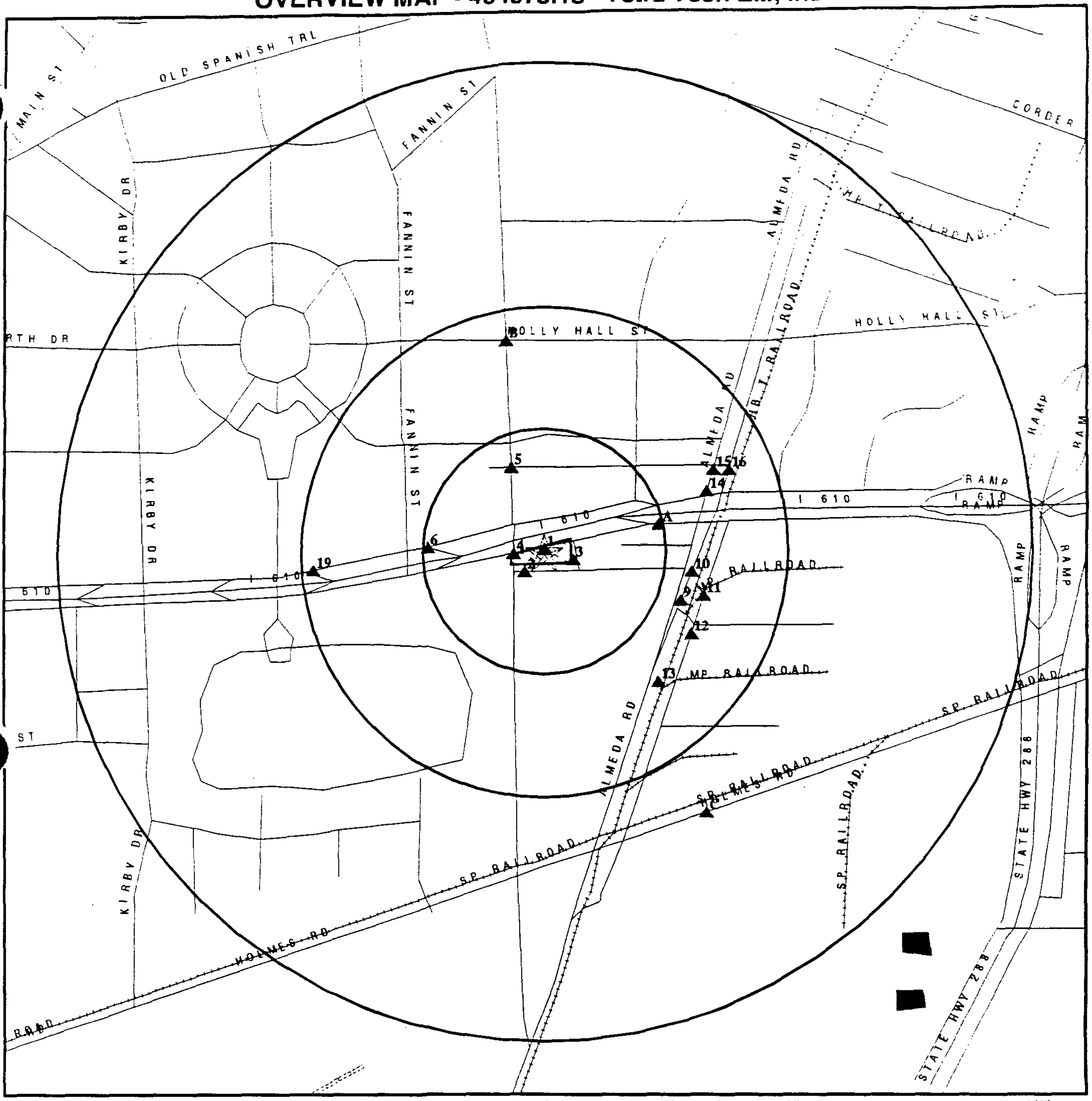
AREA RADON INFORMATION

HARRIS COUNTY, TX

Number of sites tested: 115

Area	Average Activity	% <4 pCi/L	% 4-20 pCi/L	% >20 pCi/L
Living Area - 1st Floor	0.425 pCi/L	100%	0%	0%
Living Area - 2nd Floor	Not Reported	Not Reported	Not Reported	Not Reported
Basement	Not Reported	Not Reported	Not Reported	Not Reported

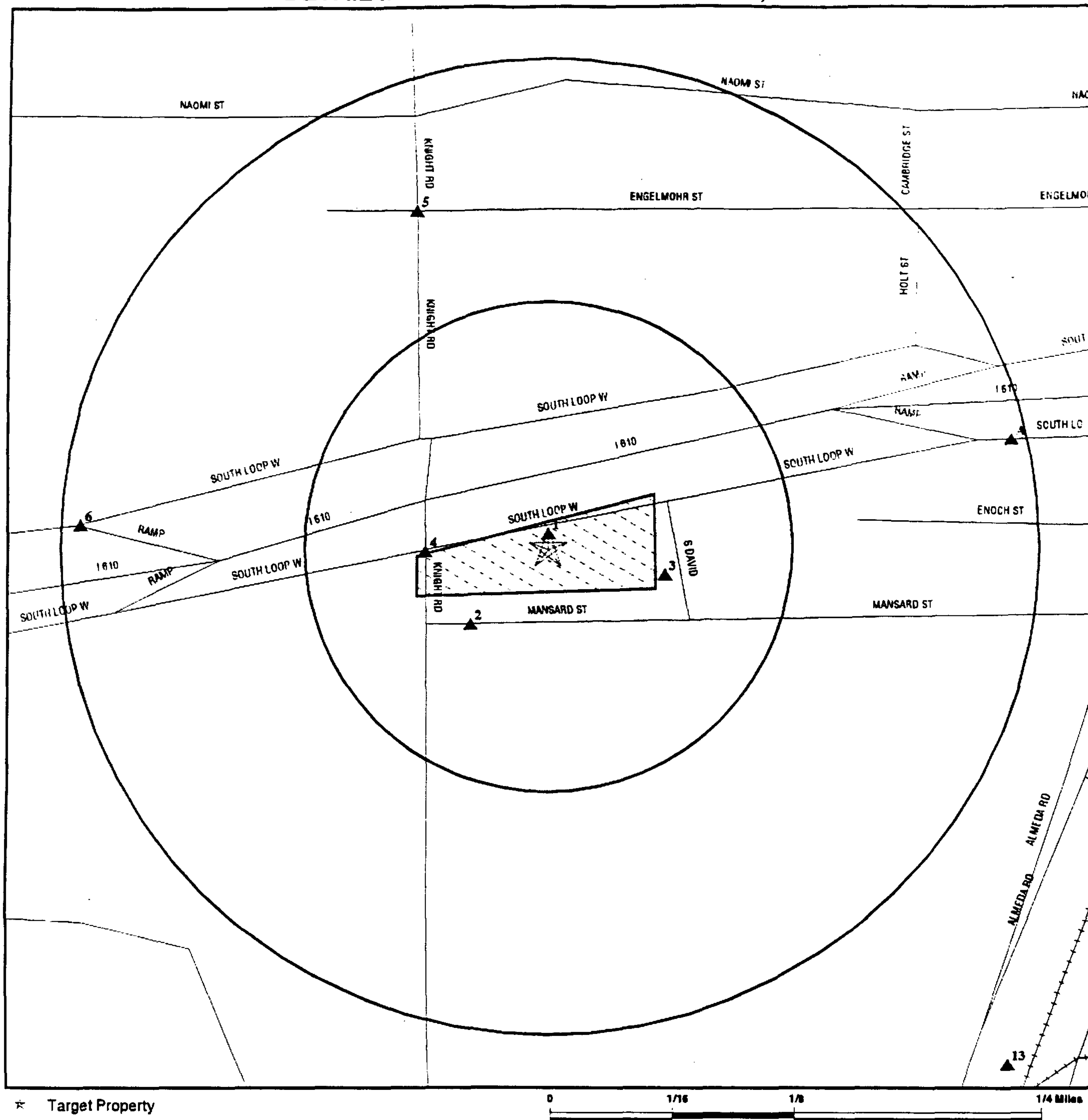
OVERVIEW MAP - 464973.1s - Tetra Tech EM, Inc.



☆ Target Property
▲ Sites at elevations higher than or equal to the target property
◆ Sites at elevations lower than the target property
▲ Coal Gasification Sites (if requested)
National Priority List Sites
Landfill Sites
Power transmission lines
Oil & Gas pipelines

TARGET PROPERTY:	Sol Lynn	CUSTOMER:	Tetra Tech EM, Inc.
ADDRESS:	1419 South Loop West	CONTACT:	Jen Seidel
CITY/STATE/ZIP:	Houston TX 77054	INQUIRY #:	464973.1s
LAT/LONG:	29.6789 / 95.3985	DATE:	February 21, 2000 8:10 am

DETAIL MAP - 464973.1s - Tetra Tech EM, Inc.



- Target Property
- Sites at elevations higher than or equal to the target property
- Sites at elevations lower than the target property
- Coal Gasification Sites (if requested)
- Sensitive Receptors
- National Priority List Sites
- Landfill Sites
- Power transmission lines
- Oil & Gas pipelines

TARGET PROPERTY:	Sol Lynn	CUSTOMER:	Tetra Tech EM, Inc.
ADDRESS:	1419 South Loop West	CONTACT:	Jen Seidel
CITY/STATE/ZIP:	Houston TX 77054	INQUIRY #:	464973.1s
LAT/LONG:	29.6789 / 95.3985	DATE:	February 21, 2000 8:11 am

MAP FINDINGS SUMMARY

Database	Target Property	Search Distance (Miles)	< 1/8	1/8 - 1/4	1/4 - 1/2	1/2 - 1	> 1	Total Plotted
FEDERAL ASTM STANDARD								
NPL	X	1.000	0	0	0	0	NR	0
Delisted NPL		1.000	0	0	0	0	NR	0
CERCLIS	X	0.500	0	0	0	NR	NR	0
CERC-NFRAP		0.250	0	0	NR	NR	NR	0
CORRACTS		1.000	0	0	0	2	NR	2
RCRIS-TSD		0.500	0	0	0	NR	NR	0
RCRIS Lg. Quan. Gen.		0.250	1	0	NR	NR	NR	1
RCRIS Sm. Quan. Gen.		0.250	2	1	NR	NR	NR	3
ERNS		TP	NR	NR	NR	NR	NR	0
STATE ASTM STANDARD								
State Haz. Waste		1.000	0	0	0	0	NR	0
State Landfill		0.500	0	0	1	NR	NR	1
CLI		0.500	0	0	0	NR	NR	0
LUST		0.500	0	1	10	NR	NR	11
UST		0.250	1	2	NR	NR	NR	3
FEDERAL ASTM SUPPLEMENTAL								
CONSENT	X	1.000	0	0	0	0	NR	0
ROD	X	1.000	0	0	0	0	NR	0
FINDS	X	TP	NR	NR	NR	NR	NR	0
HMIRS		TP	NR	NR	NR	NR	NR	0
MLTS		TP	NR	NR	NR	NR	NR	0
MINES		0.250	0	0	NR	NR	NR	0
NPL Liens		TP	NR	NR	NR	NR	NR	0
PADS		TP	NR	NR	NR	NR	NR	0
RAATS		TP	NR	NR	NR	NR	NR	0
TRIS		TP	NR	NR	NR	NR	NR	0
TSCA		TP	NR	NR	NR	NR	NR	0
STATE OR LOCAL ASTM SUPPLEMENTAL								
AST		TP	NR	NR	NR	NR	NR	0
TX Spills		TP	NR	NR	NR	NR	NR	0
TX VCP		0.500	0	0	0	NR	NR	0
Tx Multimedia		TP	NR	NR	NR	NR	NR	0
Tx Ind Haz Waste		TP	NR	NR	NR	NR	NR	0
WasteMgt		TP	NR	NR	NR	NR	NR	0
AIRS		TP	NR	NR	NR	NR	NR	0
EDR PROPRIETARY DATABASES								
Coal Gas		1.000	0	0	0	0	NR	0
AQUIFLOW - see EDR GeoCheck Summary								

TP = Target Property

NR = Not Requested at this Search Distance

* Sites may be listed in more than one database

Map ID Direction Distance Distance (ft.) Elevation	Site	Database(s)	EDR ID Number EPA ID Number

Coal Gas Site Search: No site was found in a search of Real Property Scan's ENVIROHAZ database.

NPL Region Target Property	**SOL LYNN/INDUSTRIAL TRANSFORMERS** **1415, 1417, 1419 S LOOP WEST** **HOUSTON, TX 77054**	**CERCLIS** **FINDS** **NPL** **CONSENT** **ROD**	**1000122574** **TXD980873327**
< 1/8 **1**			

CERCLIS Classification Data:

Site Incident Category:	Not reported	Federal Facility:	Not a Federal Facility
Ownership Status:	Private	NPL Status:	Currently on the Final NPL
Contact:	KAREN BOND	Contact Tel:	(214) 665-6682
Contact:	Ken Bensen	Contact Tel:	Not reported
Contact:	Carlene Chambers	Contact Tel:	(214) 665-6720
Contact:	Gus Chavarria	Contact Tel:	(214) 665-3162
Contact:	E EDMONDS	Contact Tel:	(202) 514-1032
Contact:	Carl Edlund	Contact Tel:	(214) 665-8125
Contact:	Jhana Enders	Contact Tel:	(214) 665-6654
Contact:	Ernest Franke	Contact Tel:	(214) 665-8521
Contact:	Stan Hitt	Contact Tel:	(214) 665-6735
Contact:	Bill Honker	Contact Tel:	(214) 665-6727
Contact:	P MOTT	Contact Tel:	(202) 260-3733
Contact:	Don Markham	Contact Tel:	(214) 665-6675
Contact:	Buddy Parr	Contact Tel:	(214) 665-6670
Contact:	Carlos Sanchez	Contact Tel:	(214) 665-8507
Contact:	James Turner	Contact Tel:	(214) 665-3159
Contact:	SHIRLEY WORKMAN	Contact Tel:	(214) 655-6760
Contact:	Donn Walters	Contact Tel:	Not reported

Site Description: THREE COMMERCIAL LOTS CONTAIMINATED WITH TRICHLOROETHYLENE (TCE) & PCBS. A TRANSFORMER RECLAMATION CO & CHEMICAL SUPPLY CO PROVIOUSLY USED THE PROPERTY ABOUT 75 DRUMS OF TCE ARE BELIEVED TO BE DUMPED THERE.
THREE COMMERCIAL LOTS CONTAIMINATED WITH TRICHLOROETHYLENE (TCE) & PCBS. A TRANSFORMER RECLAMATION CO & CHEMICAL SUPPLYCO PROVIOUSLY USED THE PROPERTY ABOUT 75 DRUMS OF TCE ARE BELIEVED TO BE DUMPED THERE.

CERCLIS Assessment History:

Assessment:	DISCOVERY	Completed:	19840501
Assessment:	SITE INSPECTION	Completed:	19840901
Assessment:	PROPOSAL TO NPL	Completed:	19841015
Assessment:	NPL RP SEARCH	Completed:	19850515
Assessment:	RI/FS NEGOTIATIONS	Completed:	19850815
Assessment:	FORWARD PLANNING	Completed:	19860630
Assessment:	RI/FS WORKPLAN APPROVAL BY HQ	Completed:	19860630
Assessment:	PRELIMINARY ASSESSMENT	Completed:	19870301
Assessment:	NPL RP SEARCH	Completed:	19871201
Assessment:	COMBINED RI/FS	Completed:	19880325
Assessment:	RECORD OF DECISION	Completed:	19880325
Assessment:	COMBINED RI/FS	Completed:	19880923
Assessment:	RECORD OF DECISION	Completed:	19880923
Assessment:	RD/RA NEGOTIATIONS	Completed:	19890111
Assessment:	ADMIN ORDER ON CONSENT	Completed:	19890201
Assessment:	RD/RA NEGOTIATIONS	Completed:	19890224
Assessment:	FINAL LISTING ON NPL	Completed:	19890331
Assessment:	PRP REMOVAL	Completed:	19890419

SOL LYNN/INDUSTRIAL TRANSFORMERS (Continued) 1000122574

Assessment:	REMOVAL ASSESSMENT	Completed:	19890419
Assessment:	NPL RP SEARCH	Completed:	19890515
Assessment:	CONSENT DECREE	Completed:	19900108
Assessment:	REMOVAL ASSESSMENT	Completed:	19900627
Assessment:	REGIONAL ATTORNEY ASSIGNED	Completed:	19910301
Assessment:	PRP RD	Completed:	19910612
Assessment:	REMOVAL ASSESSMENT	Completed:	19910620
Assessment:	NPL RP SEARCH	Completed:	19910628
Assessment:	REMEDIAL DESIGN	Completed:	19911231
Assessment:	ROD Amendment	Completed:	19920916
Assessment:	PRP RA	Completed:	19930503
Assessment:	CONSENT DECREE	Completed:	19931014
Assessment:	SECTION 107 LITIGATION	Completed:	19931014
Assessment:	COST RECVRY DECSN DOCMT-NO SUE	Completed:	19981228

CERCLIS Site Status:
Not reported
CERCLIS Alias Name(s):
SOL LYNN/INDUSTRIAL TRANSFORMERS

NPL:

ID:	06TX023
Date Listed:	3/31/89 (FINAL)
EPA/ID:	TXD980873327
Haz. Rank Score:	39.65
Status:	LISTED ON NPL
Rank:	511
Group:	11
Ownership:	Private
Permit:	None
Site Activities:	Containers/Drums
Site Activities:	Chemical Process/Manuf.
Site Activities:	Other Manufacturing/Industrial
Site Condition:	Contam. Drinking Water
Site Condition:	Contam. Irrigation Water
Site Condition:	Contamination of Soil
Site Condition:	Contam. Ground Water
Waste Type:	Oils

Contaminant:	Media Affected:
1,1,2-TRICHLOROETHYLENE (TCE)	Ground and Surface Water
TOLUENE	Ground Water
TETRACHLOROETHENE	Ground Water
1,2-TRANS-DICHLOROETHYLENE	Ground Water
POLYCHLORINATED BIPHENYLS, NOS	Not reported

Distance to nearest Population:	Not reported
Population within a 1 Mile Radius:	Not reported
Population within a 2 Mile Radius:	Not reported
Population within a 4 Mile Radius:	Not reported
Vertical Distance to Aquifer:	Less than 21 Feet
Ground Water Use:	Not Used as Drinking Water, Alternative Source Available
Distance to nearest Surface Water:	1 Mile to 2 Miles

ROD:
Full-text of USEPA Record of Decision(s) is available from EDR.

CONSENT:
Full-text of a consent decree on this site issued by a United States District Court is available from EDR.

SOL LYNN/INDUSTRIAL TRANSFORMERS (Continued) **1000122574**

FINDS:
Other Pertinent Environmental Activity Identified at Site:
Enforcement Docket System (DOCKET)

Map ID / Direction / Distance / Elevation	Site	Database(s)	EDR ID / EPA ID
1 **North** **< 1/8** **36** **Higher**	**INTERNATIONAL TOOL & SUPPLY CO.** **825 SOUTH LOOP W** **HOUSTON, TX 77054**	**TX IHW** **UST**	**1000646127** **N/A**

TX IHW:

Registration Number:	71556
Registration Initial Notification Date:	Not reported
Registration Last Amendment Date:	Not reported
EPA Identification:	TXT
TNRCC Premit Number:	490013653
Description of Facility Site Location:	825 South Loop W, Houston, TX
Site Primary Standard Industrial Code:	Not reported
Registration is a Generator of Waste:	Yes
Registration is a Receivers of Waste:	No
Registration is a Transporter of Waste:	No
Registration is a Transfer Facility:	No
Mexican Facility:	Does not represent a Maquiladora (Mexican Facility)
Facility Status:	Inactive
Type of Generator:	Non-industrial and/or municipal, CESQG
Company Name:	International Tool & Supply
Facility County:	Not reported
TNRCC Region:	Not reported
Mailing Address:	825 South Loop W Houston, TX 77054
Mailing County:	USA
Contact:	John Turner
Contact Telephone Number:	713-795-8778

Additional detail may be available for this site. Please contact your EDR Account Executive for more information

UST:

Facility ID:	0001097	Customer ID:	00590
Tank ID:	1	Installation Date:	Not reported
Tank Installer:	Not reported	Tank Tested:	No
Tank Emptied:	No	Status Date:	10/16/89
Capacity:	0	Unit ID:	00002797

Tank Material of Construction:	Steel
Pipe Material of Construction:	Steel
Other Materials of Construction:	Not reported
Tank Status:	Removed from the Ground
Tank Construction & Containment:	Not reported
Pipe Construction & Containment:	Not reported
Other Construction & Containment:	Not reported
Tank Substance Stored:	Diesel
Other Substance Stored:	Not reported
Tank Release Detection:	None
Pipe Release Detection:	None
Other Release Detection:	Not reported
Tank Corrosion Protection:	None
Pipe Corrosion Protection:	None
Pipe Corrosion Protection II:	Noncorrodible Material (c.g. FRP)
Other Corrosion Protection:	Not reported

INTERNATIONAL TOOL & SUPPLY CO. (Continued) **1000646127**

Spill and Overfill Protection:	Unknown/None
Spill and Overfill Protection II:	Tight-Fill Fitting
Vapor Recovery Equipment Status:	Not reported
Equipment Installed Date:	Not reported
Equipment Installer:	Not reported
Contractor Registration Number:	Not reported
Tank Registration Date:	05/08/86
Installer License Number:	Not reported

Facility ID:	0001097	Customer ID:	00590
Tank ID:	2	Installation Date:	Not reported
Tank Installer:	Not reported	Tank Tested:	No
Tank Emptied:	No	Status Date:	10/16/89
Capacity:	0	Unit ID:	00002798

Tank Material of Construction:	Fiberglass-Reinforced Plastic (FRP)
Pipe Material of Construction:	Steel
Other Materials of Construction:	Not reported
Tank Status:	Removed from the Ground
Tank Construction & Containment:	Not reported
Pipe Construction & Containment:	Not reported
Other Construction & Containment:	Not reported
Tank Substance Stored:	Not reported
Other Substance Stored:	Mineral Spirits
Tank Release Detection:	None
Pipe Release Detection:	None
Other Release Detection:	Not reported
Tank Corrosion Protection:	None
Pipe Corrosion Protection:	None
Pipe Corrosion Protection II:	Noncorrodible Material (c.g. FRP)
Other Corrosion Protection:	Not reported
Spill and Overfill Protection:	Unknown/None
Spill and Overfill Protection II:	Tight-Fill Fitting
Vapor Recovery Equipment Status:	Not reported
Equipment Installed Date:	Not reported
Equipment Installer:	Not reported
Contractor Registration Number:	Not reported
Tank Registration Date:	05/08/86
Installer License Number:	Not reported

2
SW
< 1/8
295
Higher

SOUTHWESTERN BELL TEL CO
2032 MANSARD
HOUSTON, TX 77054

RCRIS-SQG **1000410834**
FINDS **TXD981594856**

RCRIS:

Owner:	SOUTHWESTERN BELL TELE CO (214) 464-1942
Contact:	DWIGHT PURTEE (314) 247-1798
Record Date:	11/04/1986
Classification:	Small Quantity Generator

SOUTHWESTERN BELL TEL CO (Continued) **1000410834**

Used Oil Recyc: No

Violation Status: No violations found

3
ESE
< 1/8
326
Higher

INDUSTIAL TRANSPORMER SPRFUND
8921 DAVID ST
HOUSTON, TX 77054

FINDS **1000877450**
RCRIS-LQG **TXD988088399**

RCRIS:

Owner:	TEXAS WATER COMMISSION (512) 908-2442
Contact:	MARK HEMINGWAY (512) 447-9081
Record Date:	07/01/1993
Classification:	Large Quantity Generator
Used Oil Recyc:	No
Violation Status:	No violations found

4
West
< 1/8
333
Higher

SERVICE IND OF AM
8703 KNIGHT RD
HOUSTON, TX 77054

RCRIS-SQG **1000432842**
FINDS **TXD026178475**

RCRIS:

Owner:	SERVICE IND OF AM (000) 000-0000
Contact:	Not reported
Record Date:	06/10/1985
Classification:	Conditionally Exempt Small Quantity Generator
Used Oil Recyc:	No
Violation Status:	Violation information exist

There are 1 violation record(s) reported at this site:

Evaluation	Area of Violation	Date of Compliance
Compliance Evaluation Inspection (CEI)	Generator-All Requirements	05/24/1984

5
NNW
1/8-1/4
976
Higher

CUNNINGHAM AUTO
8600 KNIGHT RD
HOUSTON, TX 77054

RCRIS-SQG **1000470379**
FINDS **TXD988022752**

CUNNINGHAM AUTO (Continued) 1000470379

RCRIS:
Owner: RICHARD WILLIAMS
(713) 526-3556

Contact: RICHARD WILLIAMS
(713) 796-8477

Record Date: 12/24/1990

Classification: Small Quantity Generator

Used Oil Recyc: No

Violation Status: No violations found

6
West
1/8-1/4
1265
Higher

ASTRODOME CONOCO
1522 SOUTH LOOP W
HOUSTON, TX 77054

UST **U001261670**
N/A

UST:

Facility ID:	0027939	Customer ID:	00035
Tank ID:	1	Installation Date:	01/01/85
Tank Installer:	Not reported	Tank Tested:	Yes
Tank Emptied:	No	Status Date:	Not reported
Capacity:	6000	Unit ID:	00073110

Tank Material of Construction: Steel
Pipe Material of Construction: Fiberglass-Reinforced Plastic (FRP)
Other Materials of Construction: Not reported
Tank Status: In Use
Tank Construction & Containment: Not reported
Pipe Construction & Containment: Not reported
Other Construction & Containment: Not reported
Tank Substance Stored: Gasoline
Other Substance Stored: Not reported
Tank Release Detection: None
Pipe Release Detection: None
Other Release Detection: Not reported
Tank Corrosion Protection: Cathodic Protection System
Pipe Corrosion Protection: None
Pipe Corrosion Protection II: Noncorrodible Material (c.g. FRP)
Other Corrosion Protection: Not reported
Spill and Overfill Protection: Unknown/None
Spill and Overfill Protection II: Tight-Fill Fitting
Vapor Recovery Equipment Status: Not reported
Equipment Installed Date: Not reported
Equipment Installer: Not reported
Contractor Registration Number: Not reported
Tank Registration Date: 05/08/86
Installer License Number: Not reported

Facility ID:	0027939	Customer ID:	00035
Tank ID:	2	Installation Date:	01/01/85
Tank Installer:	Not reported	Tank Tested:	Yes
Tank Emptied:	No	Status Date:	Not reported
Capacity:	8000	Unit ID:	00073111

Tank Material of Construction: Steel
Pipe Material of Construction: Fiberglass-Reinforced Plastic (FRP)
Other Materials of Construction: Not reported

ASTRODOME CONOCO (Continued) **U001261670**

Tank Status:	In Use
Tank Construction & Containment:	Not reported
Pipe Construction & Containment:	Not reported
Other Construction & Containment:	Not reported
Tank Substance Stored:	Gasoline
Other Substance Stored:	Not reported
Tank Release Detection:	None
Pipe Release Detection:	None
Other Release Detection:	Not reported
Tank Corrosion Protection:	Cathodic Protection System
Pipe Corrosion Protection:	None
Pipe Corrosion Protection II:	Noncorrodible Material (c.g. FRP)
Other Corrosion Protection:	Not reported
Spill and Overfill Protection:	Unknown/None
Spill and Overfill Protection II:	Tight-Fill Fitting
Vapor Recovery Equipment Status:	Not reported
Equipment Installed Date:	Not reported
Equipment Installer:	Not reported
Contractor Registration Number:	Not reported
Tank Registration Date:	05/08/86
Installer License Number:	Not reported

Facility ID:	0027939	Customer ID:	00035
Tank ID:	3	Installation Date:	01/01/85
Tank Installer:	Not reported	Tank Tested:	Yes
Tank Emptied:	No	Status Date:	Not reported
Capacity:	8000	Unit ID:	00073112

Tank Material of Construction:	Steel
Pipe Material of Construction:	Fiberglass-Reinforced Plastic (FRP)
Other Materials of Construction:	Not reported
Tank Status:	In Use
Tank Construction & Containment:	Not reported
Pipe Construction & Containment:	Not reported
Other Construction & Containment:	Not reported
Tank Substance Stored:	Gasoline
Other Substance Stored:	Not reported
Tank Release Detection:	None
Pipe Release Detection:	None
Other Release Detection:	Not reported
Tank Corrosion Protection:	None
Pipe Corrosion Protection:	None
Pipe Corrosion Protection II:	Noncorrodible Material (c.g. FRP)
Other Corrosion Protection:	Not reported
Spill and Overfill Protection:	Unknown/None
Spill and Overfill Protection II:	Tight-Fill Fitting
Vapor Recovery Equipment Status:	Not reported
Equipment Installed Date:	Not reported
Equipment Installer:	Not reported
Contractor Registration Number:	Not reported
Tank Registration Date:	05/08/86
Installer License Number:	Not reported

A7	**ALL PAN INC**	**LUST**	**S103487151**
ENE	**1107 SOUTH LOOP W**		**N/A**
1/8-1/4	**HOUSTON, TX**		
1278			
Higher			

ALL PAN INC (Continued) **S103487151**

LUST:

Facility ID:	0058545	Discovery Date:	10/30/91
Data Entry Date:	3/12/93	Lead Office:	1/2
PST Coordinator:	KBS	RPR Coordinator:	RPR
Region:	12	Region City ID:	HOUSTON
Leaking Tank #:	105860		
Responsible Party:	DAO TOM C S		
RP Contact:	DAVID MARTIN		
RP Address:	909 WIRT RD 100 HOUSTON, TX 77024 - 3497		
RP Telephone:	713/957-8900		
Location:	1107 SOUTH LOOP		
County Code:	101		
Priority:	MINOR SOIL CONTAMINATION - DOES NOT REQUIRE A RAP		
Status:	FINAL CONCURRENCE ISSUED, CASE CLOSED		

A8 **ENE** **1/8-1/4** **1278** **Higher**	**ALL PAN, INC** **1107 SOUTH LOOP W** **HOUSTON, TX 77054**	**UST**	**U003409070** **N/A**

UST:

Facility ID:	0058545	Customer ID:	33752
Tank ID:	1	Installation Date:	Not reported
Tank Installer:	Not reported	Tank Tested:	Yes
Tank Emptied:	No	Status Date:	10/22/91
Capacity:	0	Unit ID:	00139624

Tank Material of Construction:	Steel
Pipe Material of Construction:	Steel
Other Materials of Construction:	Not reported
Tank Status:	Removed from the Ground
Tank Construction & Containment:	Single Wall
Pipe Construction & Containment:	Single Wall
Other Construction & Containment:	Single Wall
Tank Substance Stored:	Gasoline
Other Substance Stored:	Not reported
Tank Release Detection:	None
Pipe Release Detection:	None
Other Release Detection:	Not reported
Tank Corrosion Protection:	None
Pipe Corrosion Protection:	None
Pipe Corrosion Protection II:	Noncorrodible Material (c.g. FRP)
Other Corrosion Protection:	Not reported
Spill and Overfill Protection:	Unknown/None
Spill and Overfill Protection II:	Tight-Fill Fitting
Vapor Recovery Equipment Status:	Not reported
Equipment Installed Date:	Not reported
Equipment Installer:	Not reported
Contractor Registration Number:	Not reported
Tank Registration Date:	06/06/91
Installer License Number:	Not reported

Facility ID:	0058545	Customer ID:	33752
Tank ID:	3	Installation Date:	Not reported
Tank Installer:	Not reported	Tank Tested:	Yes
Tank Emptied:	No	Status Date:	10/22/91
Capacity:	1000	Unit ID:	00139625

ALL PAN, INC (Continued) U003409070

Tank Material of Construction:	Steel
Pipe Material of Construction:	Steel
Other Materials of Construction:	Not reported
Tank Status:	Removed from the Ground
Tank Construction & Containment:	Single Wall
Pipe Construction & Containment:	Single Wall
Other Construction & Containment:	Single Wall
Tank Substance Stored:	Gasoline
Other Substance Stored:	Not reported
Tank Release Detection:	None
Pipe Release Detection:	None
Other Release Detection:	Not reported
Tank Corrosion Protection:	None
Pipe Corrosion Protection:	None
Pipe Corrosion Protection II:	Noncorrodible Material (c.g. FRP)
Other Corrosion Protection:	Not reported
Spill and Overfill Protection:	Unknown/None
Spill and Overfill Protection II:	Tight-Fill Fitting
Vapor Recovery Equipment Status:	Not reported
Equipment Installed Date:	Not reported
Equipment Installer:	Not reported
Contractor Registration Number:	Not reported
Tank Registration Date:	06/06/91
Installer License Number:	Not reported

Facility ID:	0058545	Customer ID:	33752
Tank ID:	2	Installation Date:	Not reported
Tank Installer:	Not reported	Tank Tested:	Yes
Tank Emptied:	No	Status Date:	10/22/91
Capacity:	2000	Unit ID:	00139626

Tank Material of Construction:	Steel
Pipe Material of Construction:	Steel
Other Materials of Construction:	Not reported
Tank Status:	Removed from the Ground
Tank Construction & Containment:	Single Wall
Pipe Construction & Containment:	Single Wall
Other Construction & Containment:	Single Wall
Tank Substance Stored:	Gasoline
Other Substance Stored:	Not reported
Tank Release Detection:	None
Pipe Release Detection:	None
Other Release Detection:	Not reported
Tank Corrosion Protection:	None
Pipe Corrosion Protection:	None
Pipe Corrosion Protection II:	Noncorrodible Material (c.g. FRP)
Other Corrosion Protection:	Not reported
Spill and Overfill Protection:	Unknown/None
Spill and Overfill Protection II:	Tight-Fill Fitting
Vapor Recovery Equipment Status:	Not reported
Equipment Installed Date:	Not reported
Equipment Installer:	Not reported
Contractor Registration Number:	Not reported
Tank Registration Date:	06/06/91
Installer License Number:	Not reported

MAP FINDINGS

Map ID Direction Distance Distance (ft.) Elevation	Site	Database(s)	EDR ID Number EPA ID Number
9 **ESE** **1/4-1/2** **1569** **Higher**	**SOUTH LOOP FORD TRUCK SALES, INC** **8901 ALMEDA RD** **HOUSTON, TX 77054**	LUST	**S104158154** **N/A**

LUST:

Facility ID:	0003252	Discovery Date:	10/8/90
Data Entry Date:	2/18/91	Lead Office:	DISTRICT LEAD
PST Coordinator:	HMW	RPR Coordinator:	HELEN WELCH
Region:	12	Region City ID:	HOUSTON
Leaking Tank #:	098022		
Responsible Party:	CHARTER NATIONAL BANK		
RP Contact:	DAVID SANDERSON		
RP Address:	2600 CITADEL PLAZA DR #600 HOUSTON, TX 77008		
RP Telephone:	713/692-6121		
Location:	E ALEMDA RD		
County Code:	101		
Priority:	SOIL CONTAMINATION ONLY, REQUIRES FULL SITE ASSESSMENT & RAP		
Status:	FINAL CONCURRENCE ISSUED, CASE CLOSED		

10 **East** **1/4-1/2** **1617** **Higher**	**ALMEDA BUILDING** **8821 ALMEDA RD** **HOUSTON, TX**	**LUST**	**S104175504** **N/A**

LUST:

Facility ID:	0015547	Discovery Date:	1/29/91
Data Entry Date:	11/12/91	Lead Office:	DISTRICT LEAD
PST Coordinator:	ARP	RPR Coordinator:	ANTONIO PENA
Region:	12	Region City ID:	HOUSTON
Leaking Tank #:	100523		
Responsible Party:	KAGAN EDELMAN ENTERPRISES		
RP Contact:	LAWRENCE KAGAN		
RP Address:	8801 KNIGHT HOUSTON, TX 77054		
RP Telephone:	713/748-2000		
Location:	ALMEDA & SOUTH LOOP 610		
County Code:	101		
Priority:	SOIL CONTAMINATION ONLY, REQUIRES FULL SITE ASSESSMENT & RAP		
Status:	FINAL CONCURRENCE ISSUED, CASE CLOSED		

11 **ESE** **1/4-1/2** **1793** **Higher**	**AACI - WOODWORK DIVISION** **9011 E ALMEDA ST** **HOUSTON, TX 77055**	**LUST**	**S104176089** **N/A**

Map ID Direction Distance Distance (ft.) Elevation	Site	Database(s)	EDR ID Number EPA ID Number

AACI - WOODWORK DIVISION (Continued) S104176089

LUST:

Facility ID:	0053254	Discovery Date:	6/18/90
Data Entry Date:	5/22/91	Lead Office:	DISTRICT LEAD
PST Coordinator:	DRK	RPR Coordinator:	RICHARD KING
Region:	12	Region City ID:	HOUSTON
Leaking Tank #:	099038		
Responsible Party:	AMERICAN ARCHITECTURAL WOODWOR		
RP Contact:	R A WILKERSON		
RP Address:	9011 E ALMEDA HOUSTON, TX 77054		
RP Telephone:	713/791-1985		
Location:	E ALMEDA		
County Code:	101		
Priority:	SOIL CONTAMINATION ONLY, REQUIRES FULL SITE ASSESSMENT & RAP		
Status:	FINAL CONCURRENCE ISSUED, CASE CLOSED		

---

12 ESE 1/4-1/2 1827 Higher	**SHEPLER EQUIPMENT** **9103 E ALMEDA ST** **HOUSTON, TX 77054**	**LUST**	**S103930363** **N/A**

LUST:

Facility ID:	Not reported	Discovery Date:	5/18/93
Data Entry Date:	6/17/93	Lead Office:	1/2
PST Coordinator:	RPR	RPR Coordinator:	RPR
Region:	12	Region City ID:	HOUSTON
Leaking Tank #:	106658		
Responsible Party:	SHEPLER EQUIPMENT		
RP Contact:	BILL BARTHOLMEU		
RP Address:	9103 E ALAMEDA HOUSTON, TX 77054		
RP Telephone:	713/799-1150		
Location:	9103 E ALAMEDA		
County Code:	101		
Priority:	SOIL CONTAMINATION ONLY, REQUIRES FULL SITE ASSESSMENT & RAP		
Status:	FINAL CONCURRENCE ISSUED, CASE CLOSED		

---

13 SE 1/4-1/2 1871 Higher	**HOUSTON KNIGHT RD BTWN HWY 610 / HOLMES RD** **HOUSTON, TX**	**SWF/LF**	**S103222287** **N/A**

(Continued) **S103222287**

LF:

Facility ID:	2161
Population Served:	0
Area Served:	HOUSTON
Tons per Day:	0
Yards per Day:	0
Estimated Cleanup Date:	19010101
Removal Status:	BIO/MED
Engineer:	DAP
Status Date:	04/21/93
Business Type:	CITY
Organic Acres:	0
Facility Status:	PROPOSED SITE
Amendment:	Not reported
Recieved Date:	04/03/90
Region:	STATE
Region Code:	12
Extra Territorial Jurisdiction:	HOUSTON
Lat/Long:	29° 40.28' 0" / 95° 23.46' 0"
Applicant Name:	COMPLETE COMPLIANCE CORP.
Applicant Address:	9033 KNIGHT ROAD HOUSTON, TX 75504
Applicant Telephone:	(713) 794-0046
River Basin Code:	10
Responsible Engenier:	DAP
Start Date:	04/21/93
County Name:	Harris
County Code:	101
County:	101
County Name:	Harris
County Gov't Code:	16
County Region:	12
Fips County Code:	Not reported
Owner Name:	DARREL EDELMAN
Owner Address:	9033 KNIGHT ROAD HOUSTON, TX 77054
Facility Type:	TRANSFER STATION FACILITY
Permit Status:	Application Withdrawn

14
ENE
1/4-1/2
1877
Higher

TEXACO STATION
8610 ALMEDA RD
HOUSTON, TX 77000

LUST **S103487003**
N/A

TEXACO STATION (Continued) **S103487003**

LUST:

Facility ID:	0023169	Discovery Date:	7/16/87
Data Entry Date:	7/16/87	Lead Office:	CENTRAL OFFICE LEAD
PST Coordinator:	SEL/KMC/RJH/AFF	RPR Coordinator:	SEL
Region:	12	Region City ID:	HOUSTON
Leaking Tank #:	091386		
Responsible Party:	STAR ENTERPRISE		
RP Contact:	E T BRANDT		
RP Address:	110 CYPRESS STATION DR STE 255 HOUSTON, TX 77090		
RP Telephone:	713/586-3610		
Location:	8610 ALMEDA		
County Code:	101		
Priority:	GROUNDWATER OTHER THAN 1B, SITE CHARACTERIZATION INCOMPLETE		
Status:	FINAL MONITORING QUARTERLY REPORT OVERDUE		

Facility ID:	0023169	Discovery Date:	8/22/90
Data Entry Date:	9/26/90	Lead Office:	1/2
PST Coordinator:	SEL/UII/HMW	RPR Coordinator:	SEL
Region:	12	Region City ID:	HOUSTON
Leaking Tank #:	096627		
Responsible Party:	STAR ENTERPRISE		
RP Contact:	KYLE LANDRENEAU		
RP Address:	110 CYPRESS STATION DR STE 255 HOUSTON, TX 77090		
RP Telephone:	281/586-3613		
Location:	ALMEDA		
County Code:	101		
Priority:	GW IMPACTED, NO APPARENT THREATS OR IMPACTS TO RECEPTORS		
Status:	FINAL CONCURRENCE ISSUED, CASE CLOSED		

---

15 **CHEVRON FAC #108194** **LUST** **S103487343**
ENE **8550 ALMEDA RD** **N/A**
1/4-1/2 **HOUSTON, TX 77054**
2029
Higher

LUST:

Facility ID:	0029239	Discovery Date:	1/26/94
Data Entry Date:	4/28/94	Lead Office:	CENTRAL OFFICE LEAD
PST Coordinator:	PVB/PCC	RPR Coordinator:	PVB
Region:	12	Region City ID:	HOUSTON
Leaking Tank #:	108087		
Responsible Party:	CHEVRON PRODUCTS COMPANY		
RP Contact:	ALLYSIA KIZZEE		
RP Address:	PO BOX 4256 HOUSTON, TX 77210		
RP Telephone:	713/219-5213		
Location:	8550 ALMEDA		
County Code:	101		
Priority:	GW IMPACTED, NO APPARENT THREATS OR IMPACTS TO RECEPTORS		
Status:	PHASE 3 IN PROGRESS		

---

16 **STATE INSPECTION PLUS** **LUST** **S104175456**
ENE **8551 ALMEDA RD** **N/A**
1/4-1/2 **HOUSTON, TX**
2179
Higher

Map ID
Direction
Distance
Distance (ft.)
Elevation Site | Database(s) | EDR ID Number / EPA ID Number

STATE INSPECTION PLUS (Continued) — S104175456

LUST:

Facility ID:	0010287	Discovery Date:	7/14/92
Data Entry Date:	8/6/92	Lead Office:	DISTRICT LEAD
PST Coordinator:	HMW	RPR Coordinator:	RPR
Region:	12	Region City ID:	HOUSTON
Leaking Tank #:	103827		
Responsible Party:	SAMPERI SAM		
RP Contact:	SAM SAMPERI		
RP Address:	8011 ERIE HOUSTON, TX 77061		
RP Telephone:	713/645-7206		
Location:	8551 ALMEDA		
County Code:	101		
Priority:	MINOR SOIL CONTAMINATION - DOES NOT REQUIRE A RAP		
Status:	FINAL CONCURRENCE ISSUED, CASE CLOSED		

B17
North
1/4-1/2
2233
Higher

FEDERAL SIGN CO
8315 KNIGHT RD
HOUSTON, TX 77054

RCRIS-SQG
FINDS
LUST

1000213683
TXD982288748

RCRIS:

Owner: FEDERAL SIGNAL
(000) 000-0000

Contact: BILLY JEZEK
(713) 799-1666

Record Date: 08/14/1987

Classification: Small Quantity Generator

Used Oil Recyc: No

Violation Status: No violations found

LUST:

Facility ID:	0001415	Discovery Date:	12/22/92
Data Entry Date:	2/22/93	Lead Office:	DISTRICT LEAD
PST Coordinator:	HMW	RPR Coordinator:	HELEN WELCH
Region:	12	Region City ID:	HOUSTON
Leaking Tank #:	106005		
Responsible Party:	FEDERAL SIGN		
RP Contact:	DEETTE MATHEWS		
RP Address:	8315 KNIGHT HOUSTON, TX 77054		
RP Telephone:	713/799-1666		
Location:	8315 KNIGHT		
County Code:	101		
Priority:	SOIL CONTAMINATION - NO REMEDIAL ACTION REQUIRED		
Status:	FINAL CONCURRENCE ISSUED, CASE CLOSED		

B18
North
1/4-1/2
2311
Higher

STOP-N-GO MARKET (490)
8301 KNIGHT RD
HOUSTON, TX 77054

LUST

S104175936
N/A

STOP-N-GO MARKET (490) (Continued) **S104175936**

LUST:

Facility ID:	0039842	Discovery Date:	7/5/89
Data Entry Date:	7/25/89	Lead Office:	CENTRAL OFFICE LEAD
PST Coordinator:	LAS/KWW/WMK/MSM	RPR Coordinator:	LAS
Region:	12	Region City ID:	HOUSTON
Leaking Tank #:	093267		
Responsible Party:	NATIONAL CONVENIENCE STORES		
RP Contact:	JOHN WILLRODT		
RP Address:	PO BOX 758 HOUSTON, TX 77001 - 0758		
RP Telephone:	713/863-2318		
Location:	8301 KNIGHT RD @ HOLLY HALL		
County Code:	101		
Priority:	GROUNDWATER OTHER THAN 1B, SITE CHARACTERIZATION INCOMPLETE		
Status:	FINAL CONCURRENCE ISSUED, CASE CLOSED		

19
West
1/4-1/2
2512
Higher

1800 SOUTH LOOP W # 610
HOUSTON, TX 77027

LUST **S104157850**
N/A

LUST:

Facility ID:	Not reported	Discovery Date:	8/22/89
Data Entry Date:	10/24/89	Lead Office:	11/1
PST Coordinator:	RPR/RCB/MCL/WMK	RPR Coordinator:	KKC
Region:	12	Region City ID:	HOUSTON
Leaking Tank #:	093790		
Responsible Party:	CDI/EAST HOUSTON VENTURE I		
RP Contact:	CINDY LEWIS		
RP Address:	1800 WEST LOOP S STE 475 HOUSTON, TX 77027		
RP Telephone:	713/840-1788		
Location:	1800 S LOOP 610		
County Code:	101		
Priority:	GW IMPACTED, NO APPARENT THREATS OR IMPACTS TO RECEPTORS		
Status:	FINAL CONCURRENCE ISSUED, CASE CLOSED		

C20
SSE
1/2-1
3309
Higher

COOK COMPOSITES & POLYMERS
2434 HOLMES RD
HOUSTON, TX 77051

FINDS **1000354794**
RCRIS-LQG **TXD108999863**
TRIS
CORRACTS

CORRACTS Data:

Prioritization:	Not reported
Status:	RCRA Facility Assessment Completed

COOK COMPOSITES & POLYMERS (Continued) **1000354794**

RCRIS:
Owner: FREEMAN CHEMICAL CORP
(000) 000-0000

Contact: CHUCK EARHART
(713) 799-1800

Record Date: 01/15/1987

Classification: Large Quantity Generator

BIENNIAL REPORTS:
Last Biennial Reporting Year: 1997

Waste	Quantity (Lbs)	Waste	Quantity (Lbs)
D001	4272760.00	D002	3336740.00
D003	120.00	D018	400.00
F002	2520.00	F003	297440.00
F005	297440.00	U122	3600.00
U147	2380.00	U154	4800.00
U190	2380.00		

Used Oil Recyc: No

Violation Status: Violation information exist

There are 1 violation record(s) reported at this site:

Evaluation	Area of Violation	Date of Compliance
Compliance Evaluation Inspection (CEI)	Generator-All Requirements	01/29/1996

FINDS:
Other Pertinent Environmental Activity Identified at Site:
Enforcement Docket System (DOCKET)

C21
SSE
1/2-1
3309
Higher

MAGNA CORPORATION - HOUSTON
2434 HOLMES RD
HOUSTON, TX 77051

FINDS **1000306781**
RCRIS-LQG **TXD000807875**
TSCA
CORRACTS
CERC-NFRAP

CERCLIS-NFRAP Classification Data:
Site Incident Category: Not reported
Ownership Status: Other
Federal Facility: Not a Federal Facility
NPL Status: Not on the NPL

CERCLIS-NFRAP Assessment History:

Assessment:	DISCOVERY	Completed:	19830301
Assessment:	PRELIMINARY ASSESSMENT	Completed:	19840301
Assessment:	SITE INSPECTION	Completed:	19840301

CORRACTS Data:
Prioritization: High
Status: RCRA Facility Assessment Completed, Stabilization Measures Implemented, Stabilization Construction Completed

RCRIS Corrective Action Summary:
Effective Date: 11/30/1984
Legal Authority: Other, specified by Legal Authority Citation

Map ID Direction Distance Distance (ft.) Elevation	Site	Database(s)	EDR ID Number EPA ID Number

MAGNA CORPORATION - HOUSTON (Continued) 1000306781

RCRIS:
Owner: CHARDONOL CORPORATION
(713) 795-4270

Contact: RON LOUTERS
(713) 799-1800

Record Date: 01/21/1998

Classification: Large Quantity Generator, TSDF

Used Oil Recyc: No

TSDF Activities: Not reported

Violation Status: No violations found

ORPHAN SUMMARY

City	EDR ID	Site Name	Site Address	Zip	Database(s)	Facility ID
HOUSTON	1001198003	AAMCO TRANSMISSIONS	1377 HWY 610 S LOOP WEST	77054	RCRIS-SQG, FINDS, TX IHW	TXR
HOUSTON	S103221364		500'E OF IH610,S OF PORT TERMI		SWF/LF	1074
HOUSTON	1001216374	MIKE CALVERT TOYOTA BODY SHOP	2333 S LOOP WEST	77054	RCRIS-SQG, FINDS	
HOUSTON	1001225749	GILLESPIE PETROLEUM INC	2616 S LOOP WEST	77054	RCRIS-SQG, FINDS	
HOUSTON	S103500251	CHEVRON #60-108129	717 NORTH LOOP # 610E		LUST	0029253
HOUSTON	S103486929	FORMER MOBIL SS #12-409	1525 NORTH LOOP # 610W		LUST	0017576
HOUSTON	S103865316	FORMER WAUKESHA-PEARCE INDUSTRIES	825 SOUTH LOOP 610 WEST		TX VCP	960
HOUSTON	S104175949	DIAMOND SHAMROCK #260	404 N LOOP 610		LUST	0040127
HOUSTON	S103597330		W SIDE OF FM-521, 3-1/2MI N OF		SWF/LF	1505
HOUSTON	1001405640	FEDERATED METALS	THE FEDERATED METALS SUPERFUND		SHWS	
HOUSTON	S104235692	WASTE OIL TANK SERVICE	THE WASTE OIL TANK SERVICE SIT		SHWS	
HOUSTON	S104105322	LA PATA OIL	THE LA PATA OIL SITE IS LOCATE		SHWS	

GEOCHECK VERSION 2.1 ADDENDUM
GROUNDWATER FLOW INFORMATION

Map ID Direction Distance Elevation	Site	
3g **NNW** **1 - 2 Miles** **Lower**	Site ID: Groundwater Flow: Shallowest Water Table Depth: Deepest Water Table Depth: Average Water Table Depth: Date:	103110 SE 11.95 16.81 Not Reported 9/25/96
4g **NNW** **1 - 2 Miles** **Lower**	Site ID: Groundwater Flow: Shallowest Water Table Depth: Deepest Water Table Depth: Average Water Table Depth: Date:	103075 NOT REPORTED 21.95 Not Reported Not Reported 3/12/97
5g **ENE** **1/4 - 1/2 Mile** **Lower**	Site ID: Groundwater Flow: Shallowest Water Table Depth: Deepest Water Table Depth: Average Water Table Depth: Date:	108220 VARIES 11.75 12.42 Not Reported 1-1996
6g **ENE** **1/4 - 1/2 Mile** **Lower**	Site ID: Groundwater Flow: Shallowest Water Table Depth: Deepest Water Table Depth: Average Water Table Depth: Date:	108220 VARIES 11.75 12.42 Not Reported 1-1996
7g **West** **1 - 2 Miles** **Lower**	Site ID: Groundwater Flow: Shallowest Water Table Depth: Deepest Water Table Depth: Average Water Table Depth: Date:	108135 NOT REPORTED 9 12 Not Reported 11-27-95
8g **West** **1 - 2 Miles** **Lower**	Site ID: Groundwater Flow: Shallowest Water Table Depth: Deepest Water Table Depth: Average Water Table Depth: Date:	108353 Not Reported Not Reported 1.80' 9.85' 03/24/97
10g **West** **1 - 2 Miles** **Lower**	Site ID: Groundwater Flow: Shallowest Water Table Depth: Deepest Water Table Depth: Average Water Table Depth: Date:	106351 SW 7.42' 10.80' Not Reported 06-05-97
11g **West** **1 - 2 Miles** **Lower**	Site ID: Groundwater Flow: Shallowest Water Table Depth: Deepest Water Table Depth: Average Water Table Depth: Date:	106351 SW 7.42' 10.80' Not Reported 06-05-97

GEOCHECK VERSION 2.1
GROUNDWATER FLOW INFORMATION

Map ID Direction Distance Elevation	Site	
13g	Site ID:	110655
WSW	Groundwater Flow:	W
1/2 - 1 Mile	Shallowest Water Table Depth:	12.6ft
Lower	Deepest Water Table Depth:	14.2ft
	Average Water Table Depth:	Not Reported
	Date:	2/97
15g	Site ID:	106204
WSW	Groundwater Flow:	N
1/2 - 1 Mile	Shallowest Water Table Depth:	1.95'
Lower	Deepest Water Table Depth:	2.85'
	Average Water Table Depth:	Not Reported
	Date:	07/14/95
16g	Site ID:	106204
WSW	Groundwater Flow:	N
1/2 - 1 Mile	Shallowest Water Table Depth:	1.95'
Lower	Deepest Water Table Depth:	2.85'
	Average Water Table Depth:	Not Reported
	Date:	07/14/95
17g	Site ID:	106204
WSW	Groundwater Flow:	N
1/2 - 1 Mile	Shallowest Water Table Depth:	1.95'
Lower	Deepest Water Table Depth:	2.85'
	Average Water Table Depth:	Not Reported
	Date:	07/14/95
19g	Site ID:	109969
WSW	Groundwater Flow:	ESE
1/2 - 1 Mile	Shallowest Water Table Depth:	9.00
Lower	Deepest Water Table Depth:	15.00
	Average Water Table Depth:	Not Reported
	Date:	DEC 4, 96
20g	Site ID:	107691
SW	Groundwater Flow:	VARIES
1/2 - 1 Mile	Shallowest Water Table Depth:	4.82'
Lower	Deepest Water Table Depth:	6.21'
	Average Water Table Depth:	Not Reported
	Date:	03-28-97
21g	Site ID:	097551
SW	Groundwater Flow:	Not Reported
1/2 - 1 Mile	Shallowest Water Table Depth:	13.58ft
Lower	Deepest Water Table Depth:	14.50ft
	Average Water Table Depth:	Not Reported
	Date:	3/91

Map ID
Direction
Distance
Elevation Site

The following regulatory files were reviewed by a member of EDR's professional field research team in an effort to identify groundwater flow direction and depth information. However, this information was not evident in the reports. This may be for a number of reasons, such as groundwater monitoring wells not being part of the field work or groundwater not having been encountered during drilling. This information is provided to save you time and money in the conduct of your hydrogeological research.

Map ID	Date	Type Of Report
1g	Not Reported	Not Reported
2g	Not Reported	Not Reported
9g	7/97	Not Reported
12g	3/96	Not Reported
14g	6/90	Not Reported
18g	1/93	Not Reported

GEOCHECK VERSION 2.1
FEDERAL DATABASE WELL INFORMATION

Well Closest to Target Property (Northern Quadrant)

BASIC WELL DATA

Site ID:	294230095232201	Distance from TP:	>2 Miles
Site Type:	Single well, other than collector or Ranney type		
Year Constructed:	Not Reported	County:	Harris
Altitude:	44.00 ft.	State:	Texas
Well Depth:	1822.00 ft.	Topographic Setting:	Not Reported
Depth to Water Table:	326.80 ft.	Prim. Use of Site:	Withdrawal of water
Date Measured:	09121968	Prim. Use of Water:	Public supply

LITHOLOGIC DATA

Geologic Age ID (Era/System/Series):	Cenozoic-Tertiary-Pliocene
Principal Lithology of Unit:	Not Reported
Further Description:	Not Reported

WATER LEVEL VARIABILITY

Water Level:	243.70 ft.	Water Level:	211.53 ft.	Water Level:	223.83 ft.	Water Level:	218.40 ft.
Date Measured:	10/08/54	Date Measured:	02/28/55	Date Measured:	03/04/57	Date Measured:	03/05/58
Water Level:	232.19 ft.	Water Level:	215.38 ft.	Water Level:	215.13 ft.	Water Level:	222.00 ft.
Date Measured:	09/30/58	Date Measured:	03/10/59	Date Measured:	03/11/60	Date Measured:	05/01/60
Water Level:	228.34 ft.	Water Level:	253.72 ft.	Water Level:	308.90 ft.	Water Level:	322.82 ft.
Date Measured:	02/01/62	Date Measured:	02/12/64	Date Measured:	02/15/68	Date Measured:	09/12/68
Water Level:	299.16 ft.	Water Level:	308.04 ft.	Water Level:	318.10 ft.	Water Level:	322.15 ft.
Date Measured:	02/18/69	Date Measured:	02/25/70	Date Measured:	02/10/71	Date Measured:	01/26/72
Water Level:	331.00 ft.	Water Level:	333.00 ft.	Water Level:	376.00 ft.	Water Level:	385.00 ft.
Date Measured:	02/14/73	Date Measured:	04/01/74	Date Measured:	01/23/78	Date Measured:	01/10/79
Water Level:	369.00 ft.	Water Level:	372.00 ft.	Water Level:	377.00 ft.	Water Level:	376.00 ft.
Date Measured:	01/16/80	Date Measured:	01/16/81	Date Measured:	01/07/82	Date Measured:	01/24/83
Water Level:	378.00 ft.	Water Level:	344.85 ft.	Water Level:	348.00 ft.	Water Level:	306.91 ft.
Date Measured:	01/10/84	Date Measured:	01/09/85	Date Measured:	01/28/86	Date Measured:	01/11/88
Water Level:	313.02 ft.	Water Level:	315.88 ft.	Water Level:	338.42 ft.	Water Level:	299.57 ft.
Date Measured:	01/13/89	Date Measured:	01/08/90	Date Measured:	01/07/91	Date Measured:	01/23/92

GEOCHECK VERSION 2.1
FEDERAL DATABASE WELL INFORMATION

Well Closest to Target Property (Eastern Quadrant)

BASIC WELL DATA

Site ID:	293958095221401	Distance from TP:	1 - 2 Miles
Site Type:	Single well, other than collector or Ranney type		
Year Constructed:	Not Reported	County:	Harris
Altitude:	51.00 ft.	State:	Texas
Well Depth:	1225.00 ft.	Topographic Setting:	Not Reported
Depth to Water Table:	259.89 ft.	Prim. Use of Site:	Destroyed
Date Measured:	06271967	Prim. Use of Water:	Public supply

LITHOLOGIC DATA

Geologic Age ID (Era/System/Series):	Cenozoic-Tertiary-Pliocene
Principal Lithology of Unit:	Not Reported
Further Description:	Not Reported

WATER LEVEL VARIABILITY

Water Level:	259.39 ft.	Water Level:	273.00 ft.	Water Level:	266.00 ft.	Water Level:	268.41 ft.
Date Measured:	06/27/67	Date Measured:	09/14/67	Date Measured:	03/04/68	Date Measured:	03/06/69
Water Level:	268.74 ft.	Water Level:	350.70 ft.	Water Level:	344.40 ft.	Water Level:	354.56 ft.
Date Measured:	02/06/73	Date Measured:	09/11/74	Date Measured:	09/11/75	Date Measured:	09/02/77
Water Level:	298.20 ft.	Water Level:	308.46 ft.	Water Level:	288.00 ft.	Water Level:	314.73 ft.
Date Measured:	01/23/78	Date Measured:	01/11/79	Date Measured:	01/16/80	Date Measured:	01/06/82
Water Level:	309.35 ft.	Water Level:	297.88 ft.	Water Level:	314.80 ft.		
Date Measured:	01/28/83	Date Measured:	01/06/84	Date Measured:	01/28/85		

GEOCHECK VERSION 2.1
FEDERAL DATABASE WELL INFORMATION

Well Closest to Target Property (Southern Quadrant)

BASIC WELL DATA

Site ID:	293850095242801	Distance from TP:	>2 Miles
Site Type:	Single well, other than collector or Ranney type		
Year Constructed:	1967	County:	Harris
Altitude:	60.00 ft.	State:	Texas
Well Depth:	Not Reported	Topographic Setting:	Flat surface
Depth to Water Table:	Not Reported	Prim. Use of Site:	Withdrawal of water
Date Measured:	Not Reported	Prim. Use of Water:	Industrial

LITHOLOGIC DATA

Not Reported

WATER LEVEL VARIABILITY

Not Reported

GEOCHECK VERSION 2.1
FEDERAL DATABASE WELL INFORMATION

Well Closest to Target Property (Western Quadrant)

BASIC WELL DATA

Site ID:	294107095262401	Distance from TP:	>2 Miles
Site Type:	Single well, other than collector or Ranney type		
Year Constructed:	Not Reported	County:	Harris
Altitude:	52.00 ft.	State:	Texas
Well Depth:	1860.00 ft.	Topographic Setting:	Not Reported
Depth to Water Table:	208.14 ft.	Prim. Use of Site:	Withdrawal of water
Date Measured:	06051955	Prim. Use of Water:	Public supply

LITHOLOGIC DATA

Geologic Age ID (Era/System/Series):	Cenozoic-Tertiary-Pliocene
Principal Lithology of Unit:	Not Reported
Further Description:	Not Reported

WATER LEVEL VARIABILITY

Water Level:	197.51 ft.	Water Level:	200.00 ft.	Water Level:	187.20 ft.	Water Level:	228.07 ft.
Date Measured:	06/05/55	Date Measured:	10/04/55	Date Measured:	03/01/56	Date Measured:	10/08/56
Water Level:	203.00 ft.	Water Level:	220.15 ft.	Water Level:	216.25 ft.	Water Level:	204.30 ft.
Date Measured:	03/11/57	Date Measured:	10/02/57	Date Measured:	10/10/57	Date Measured:	03/10/58
Water Level:	211.56 ft.	Water Level:	198.01 ft.	Water Level:	202.55 ft.	Water Level:	206.20 ft.
Date Measured:	09/30/58	Date Measured:	02/27/59	Date Measured:	03/11/60	Date Measured:	03/07/61
Water Level:	219.12 ft.	Water Level:	229.70 ft.	Water Level:	234.17 ft.	Water Level:	241.32 ft.
Date Measured:	03/15/62	Date Measured:	03/08/63	Date Measured:	02/18/64	Date Measured:	02/23/65
Water Level:	255.60 ft.	Water Level:	260.40 ft.	Water Level:	304.00 ft.	Water Level:	285.00 ft.
Date Measured:	03/02/66	Date Measured:	02/15/67	Date Measured:	10/03/68	Date Measured:	03/04/70
Water Level:	293.00 ft.	Water Level:	287.00 ft.	Water Level:	306.90 ft.	Water Level:	303.82 ft.
Date Measured:	02/23/71	Date Measured:	02/03/72	Date Measured:	02/15/73	Date Measured:	02/05/75
Water Level:	306.23 ft.	Water Level:	335.05 ft.	Water Level:	343.00 ft.	Water Level:	353.00 ft.
Date Measured:	02/06/76	Date Measured:	02/07/77	Date Measured:	01/06/78	Date Measured:	01/19/79
Water Level:	337.00 ft.	Water Level:	335.00 ft.	Water Level:	341.00 ft.	Water Level:	344.00 ft.
Date Measured:	01/10/80	Date Measured:	01/23/81	Date Measured:	01/15/82	Date Measured:	01/04/83
Water Level:	342.00 ft.	Water Level:	319.00 ft.	Water Level:	336.83 ft.	Water Level:	322.00 ft.
Date Measured:	01/04/84	Date Measured:	01/16/85	Date Measured:	01/22/86	Date Measured:	01/06/88
Water Level:	315.82 ft.	Water Level:	322.00 ft.	Water Level:	307.00 ft.		
Date Measured:	02/11/88	Date Measured:	01/17/91	Date Measured:	01/22/92		

GEOCHECK VERSION 2.1
STATE DATABASE WELL INFORMATION

Water Well Information:

Well Within 1/2 - 1 Mile of Target Property (Northern Quadrant)

Well Number:	6521620		
Owner:	Harris County Flood Control District		
Driller:	Layne Texas		
Basin:	San Jacinto River		
Accuracy of Coordinates:	Taken from center of 2 1/2 min quadrangle based on state well number		
Latitude:	952345	Longitude:	294115
Info Source:	Texas Water Development Board	Previous Well Number:	Not Reported
FIPS County Code:	201	County:	Harris
Zone:	1	Region Number:	8
Aquifer Code:	112CHCTL	Users Code Economics:	Not Reported
Ground Elevation AMSL:	52	Elevation Method:	METHOD UNKNOWN
Date Drilled:	1960	Well Type:	Withdrawal of Water
Well Depth (ft):	432	Source of Depth Data:	Not Reported
Type of Lift:	Turbine Pump	Type of Power:	Not Reported
Horsepower:	7.5	Tertiary Water Use:	Not Reported
Primary Water Use:	Domestic	Secondary Water Use:	Not Reported
Well Schedule in file:	Not Reported	Construction Method:	Not Reported
Method of Finish:	Not Reported	Lithological Log Type:	Not Reported
Casing Material:	Not Reported	Screen Material:	Not Reported
Lithological Interpreter:	Not Reported	Interpretation Date:	Not Reported
Qlty Analysis Available:	Yes	Level Data Available:	Miscellaneous water-level measurements
Data Collection Date:	Not Reported	Reporting Agency:	Not Reported
Water Logs Available:	Not Reported		
Other Data Available:	Not Reported		
Aquifer:	CHICOT AQUIFER,LOWER		

Water Quality Information::

Sample Number:	Not Reported	Sample Date:	11/26/1960
Temperature (C):	Not Reported	Sampled Aquifer Code:	Not Reported
Top of sampled interval:	Not Reported	Bottom of sampled interval:	Not Reported
Balanced/unbal Analysis:	Unbalanced	Collection Agency:	Not Reported
Silica Flag:	Not Reported	Silica MGL:	23.0
Calcium Flag:	Not Reported	Calcium MGL:	38.0
Magnesium Flag:	9	Magnesium MGL:	Not Reported
Sodium Flag:	Not Reported	Sodium MGL:	48.0
Potassium Flag:	Not Reported	Potassium MGL:	Not Reported
Strontium Flag:	Not Reported	Strontium MGL:	Not Reported
Carbonate MGL:	0.0	Bicarbonate MGL:	242.0
Sulfate Flag:	Not Reported	Sulfate MGL:	0.0
Chloride Flag:	Not Reported	Chloride MGL:	27.0
Fluoride Flag:	Not Reported	Fluoride MGL:	Not Reported
Nitrate Flag:	Not Reported	Nitrate Flag:	Not Reported
pH Flag:	Not Reported	pH:	8.1
Total Dissolved Fluids:	Not Reported	Total Hardness:	132
Phenol Alkalinity:	0.0	Total Alkalinity:	198.36
SAR:	1.82	RSC:	1.33
Specific Conductance:	450	Spec. Conductance Flag:	Not Reported
Percent Sodium:	44		
Collection Remark:	Not Reported		
Reliability Remark:	RELIABILITY UNKNOWN, NOT AVAILABLE, OR NOT YET ENTERED INTO DATABASE		
Lab Name:	Not Reported		

GEOCHECK VERSION 2.1
STATE DATABASE WELL INFORMATION

Sample Number:	Not Reported	Sample Date:	12/22/1960
Temperature (C):	Not Reported	Sampled Aquifer Code:	Not Reported
Top of sampled interval:	Not Reported	Bottom of sampled interval:	Not Reported
Balanced/unbal Analysis:	Unbalanced	Collection Agency:	Not Reported
Silica Flag:	Not Reported	Silica MGL:	29.0
Calcium Flag:	Not Reported	Calcium MGL:	47.0
Magnesium Flag:	9	Magnesium MGL:	Not Reported
Sodium Flag:	Not Reported	Sodium MGL:	50.0
Potassium Flag:	Not Reported	Potassium MGL:	Not Reported
Strontium Flag:	Not Reported	Strontium MGL:	Not Reported
Carbonate MGL:	0.0	Bicarbonate MGL:	275.0
Sulfate Flag:	Not Reported	Sulfate MGL:	0.0
Chloride Flag:	Not Reported	Chloride MGL:	27.0
Fluoride Flag:	Not Reported	Fluoride MGL:	Not Reported
Nitrate Flag:	Not Reported	Nitrate Flag:	Not Reported
pH Flag:	Not Reported	pH:	7.6
Total Dissolved Fluids:	Not Reported	Total Hardness:	154
Phenol Alkalinity:	0.0	Total Alkalinity:	225.41
SAR:	1.75	RSC:	1.42
Specific Conductance:	490	Spec. Conductance Flag:	Not Reported
Percent Sodium:	41		
Collection Remark:	Not Reported		

Reliability Remark: RELIABILITY UNKNOWN, NOT AVAILABLE, OR NOT YET ENTERED INTO DATABASE
Lab Name: Not Reported

Water Level Information::

Measurement Number: 01
Depth from land surface: -157.0 Measurement Date: 12/22/1960
Visit Mark: Publishable - water-level is indicative of aquifer's piezometric surface
Measurement Method: Steel Tape Measuring Agency: Texas Water Development Board
Remark: MEASUREMENT GOOD. NO UNUSUAL CONDITIONS NOTED AT OR NEAR WELL SITE

Infrequent Constituent Information::

Sample Number:	1	Storet Number:	01045
Sample Flag:	Not Reported	Sample Date:	11/26/1960
Constituent Value:	100.	Confidence (+ or -):	Not Reported
Storet Code Description:	IRON, TOTAL (UG/L AS FE)		
Constituent Name:	IRON	Unit of Measurement:	UG/L

Sample Number:	1	Storet Number:	01045
Sample Flag:	Not Reported	Sample Date:	12/22/1960
Constituent Value:	400.	Confidence (+ or -):	Not Reported
Storet Code Description:	IRON, TOTAL (UG/L AS FE)		
Constituent Name:	IRON	Unit of Measurement:	UG/L

Remarks:

Screen from 371 to 421 ft. Reported yield 62 gpm with 46 ft drawdown when drilled. Test hole drilled to 470 ft. Supplies office.

GEOCHECK VERSION 2.1
STATE DATABASE WELL INFORMATION

Well Within 1 - 2 Miles of Target Property (Eastern Quadrant)

Well Number:	6522711		
Owner:	City of Houston Bellfort Plant		
Driller:	Katy Drilling		
Basin:	San Jacinto River		
Accuracy of Coordinates:	Not Reported		
Latitude:	952214	Longitude:	293958
Info Source:	Texas Water Development Board	Previous Well Number:	Not Reported
FIPS County Code:	201	County:	Harris
Zone:.	1	Region Number:	8
Aquifer Code:	112CEVG	Users Code Economics:	396200
Ground Elevation AMSL:	51	Elevation Method:	METHOD UNKNOWN
Date Drilled:	1967	Well Type:	Withdrawal of Water
Well Depth (ft):	1225	Source of Depth Data:	Not Reported
Type of Lift:	Turbine Pump	Type of Power:	Not Reported
Horsepower:	300	Tertiary Water Use:	Not Reported
Primary Water Use:	Public Supply	Secondary Water Use:	Not Reported
Well Schedule in file:	Not Reported	Construction Method:	Not Reported
Method of Finish:	Not Reported	Lithological Log Type:	Not Reported
Casing Material:	Not Reported	Screen Material:	Not Reported
Lithological Interpreter:	Not Reported	Interpretation Date:	Not Reported
Qlty Analysis Available:	Yes	Level Data Available:	Historical water-level observation well
Data Collection Date:	08221996	Reporting Agency:	Not Reported
Water Logs Available:	Not Reported		
Other Data Available:	Not Reported		
Aquifer:	CHICOT AND EVANGELINE AQUIFERS		

Water Quality Information::

Sample Number:	Not Reported	Sample Date:	6/27/1967
Temperature (C):	24	Sampled Aquifer Code:	Not Reported
Top of sampled interval:	Not Reported	Bottom of sampled interval:	Not Reported
Balanced/unbal Analysis:	Balanced	Collection Agency:	Not Reported
Silica Flag:	Not Reported	Silica MGL:	20.0
Calcium Flag:	Not Reported	Calcium MGL:	44.0
Magnesium Flag:	8	Magnesium MGL:	Not Reported
Sodium Flag:	Not Reported	Sodium MGL:	56.0
Potassium Flag:	Not Reported	Potassium MGL:	1.6
Strontium Flag:	Not Reported	Strontium MGL:	Not Reported
Carbonate MGL:	0.0	Bicarbonate MGL:	259.0
Sulfate Flag:	Not Reported	Sulfate MGL:	14.0
Chloride Flag:	Not Reported	Chloride MGL:	27.0
Fluoride Flag:	Not Reported	Fluoride MGL:	0.3
Nitrate Flag:	Not Reported	Nitrate Flag:	0.0
pH Flag:	Not Reported	pH:.	7.8
Total Dissolved Fluids:	Not Reported	Total Hardness:	144
Phenol Alkalinity:	0.0	Total Alkalinity:	212.3
SAR:	2.04	RSC:	1.39
Specific Conductance:	503	Spec. Conductance Flag:	Not Reported
Percent Sodium:	45		
Collection Remark:	Not Reported		
Reliability Remark:	RELIABILITY UNKNOWN, NOT AVAILABLE, OR NOT YET ENTERED INTO DATABASE		
Lab Name:	Not Reported		

GEOCHECK VERSION 2.1
STATE DATABASE WELL INFORMATION

Sample Number:	Not Reported	Sample Date:	4/2/1968
Temperature (C):	26	Sampled Aquifer Code:	Not Reported
Top of sampled interval:	Not Reported	Bottom of sampled interval:	Not Reported
Balanced/unbal Analysis:	Unbalanced	Collection Agency:	Not Reported
Silica Flag:	Not Reported	Silica MGL:	Not Reported
Calcium Flag:	Not Reported	Calcium MGL:	Not Reported
Magnesium Flag:	Not Reported	Magnesium MGL:	Not Reported
Sodium Flag:	Not Reported	Sodium MGL:	Not Reported
Potassium Flag:	Not Reported	Potassium MGL:	Not Reported
Strontium Flag:	Not Reported	Strontium MGL:	Not Reported
Carbonate MGL:	0.0	Bicarbonate MGL:	222.0
Sulfate Flag:	Not Reported	Sulfate MGL:	Not Reported
Chloride Flag:	Not Reported	Chloride MGL:	63.0
Fluoride Flag:	Not Reported	Fluoride MGL:	Not Reported
Nitrate Flag:	Not Reported	Nitrate Flag:	Not Reported
pH Flag:	Not Reported	pH:	7.7
Total Dissolved Fluids:	Not Reported	Total Hardness:	Not Reported
Phenol Alkalinity:	0.0	Total Alkalinity:	181.97
SAR:	Not Reported	RSC:	Not Reported
Specific Conductance:	831	Spec. Conductance Flag:	Not Reported
Percent Sodium:	Not Reported		
Collection Remark:	Not Reported		
Reliability Remark:	RELIABILITY UNKNOWN, NOT AVAILABLE, OR NOT YET ENTERED INTO DATABASE		
Lab Name:	Not Reported		

Sample Number:	Not Reported	Sample Date:	2/19/1969
Temperature (C):	26	Sampled Aquifer Code:	Not Reported
Top of sampled interval:	Not Reported	Bottom of sampled interval:	Not Reported
Balanced/unbal Analysis:	Unbalanced	Collection Agency:	Not Reported
Silica Flag:	Not Reported	Silica MGL:	Not Reported
Calcium Flag:	Not Reported	Calcium MGL:	Not Reported
Magnesium Flag:	Not Reported	Magnesium MGL:	Not Reported
Sodium Flag:	Not Reported	Sodium MGL:	Not Reported
Potassium Flag:	Not Reported	Potassium MGL:	Not Reported
Strontium Flag:	Not Reported	Strontium MGL:	Not Reported
Carbonate MGL:	0.0	Bicarbonate MGL:	244.0
Sulfate Flag:	Not Reported	Sulfate MGL:	Not Reported
Chloride Flag:	Not Reported	Chloride MGL:	151.0
Fluoride Flag:	Not Reported	Fluoride MGL:	Not Reported
Nitrate Flag:	Not Reported	Nitrate Flag:	Not Reported
pH Flag:	Not Reported	pH:	7.7
Total Dissolved Fluids:	Not Reported	Total Hardness:	Not Reported
Phenol Alkalinity:	0.0	Total Alkalinity:	200.0
SAR:	Not Reported	RSC:	Not Reported
Specific Conductance:	887	Spec. Conductance Flag:	Not Reported
Percent Sodium:	Not Reported		
Collection Remark:	Not Reported		
Reliability Remark:	RELIABILITY UNKNOWN, NOT AVAILABLE, OR NOT YET ENTERED INTO DATABASE		
Lab Name:	Not Reported		

Sample Number:	Not Reported	Sample Date:	5/16/1969
Temperature (C):	26	Sampled Aquifer Code:	Not Reported
Top of sampled interval:	Not Reported	Bottom of sampled interval:	Not Reported
Balanced/unbal Analysis:	Unbalanced	Collection Agency:	Not Reported
Silica Flag:	Not Reported	Silica MGL:	Not Reported
Calcium Flag:	Not Reported	Calcium MGL:	Not Reported
Magnesium Flag:	Not Reported	Magnesium MGL:	Not Reported
Sodium Flag:	Not Reported	Sodium MGL:	Not Reported
Potassium Flag:	Not Reported	Potassium MGL:	Not Reported
Strontium Flag:	Not Reported	Strontium MGL:	Not Reported
Carbonate MGL:	0.0	Bicarbonate MGL:	242.0
Sulfate Flag:	Not Reported	Sulfate MGL:	Not Reported
Chloride Flag:	Not Reported	Chloride MGL:	166.0
Fluoride Flag:	Not Reported	Fluoride MGL:	Not Reported
Nitrate Flag:	Not Reported	Nitrate Flag:	Not Reported
pH Flag:	Not Reported	pH:	7.6
Total Dissolved Fluids:	Not Reported	Total Hardness:	Not Reported
Phenol Alkalinity:	0.0	Total Alkalinity:	198.36
SAR:	Not Reported	RSC:	Not Reported
Specific Conductance:	922	Spec. Conductance Flag:	Not Reported
Percent Sodium:	Not Reported		
Collection Remark:	Not Reported		
Reliability Remark:	RELIABILITY UNKNOWN, NOT AVAILABLE, OR NOT YET ENTERED INTO DATABASE		
Lab Name:	Not Reported		

Sample Number:	Not Reported	Sample Date:	8/4/1969
Temperature (C):	26	Sampled Aquifer Code:	Not Reported
Top of sampled interval:	Not Reported	Bottom of sampled interval:	Not Reported
Balanced/unbal Analysis:	Unbalanced	Collection Agency:	Not Reported
Silica Flag:	Not Reported	Silica MGL:	Not Reported
Calcium Flag:	Not Reported	Calcium MGL:	Not Reported
Magnesium Flag:	Not Reported	Magnesium MGL:	Not Reported
Sodium Flag:	Not Reported	Sodium MGL:	Not Reported
Potassium Flag:	Not Reported	Potassium MGL:	Not Reported
Strontium Flag:	Not Reported	Strontium MGL:	Not Reported
Carbonate MGL:	0.0	Bicarbonate MGL:	240.0
Sulfate Flag:	Not Reported	Sulfate MGL:	Not Reported
Chloride Flag:	Not Reported	Chloride MGL:	157.0
Fluoride Flag:	Not Reported	Fluoride MGL:	Not Reported
Nitrate Flag:	Not Reported	Nitrate Flag:	Not Reported
pH Flag:	Not Reported	pH:	7.7
Total Dissolved Fluids:	Not Reported	Total Hardness:	Not Reported
Phenol Alkalinity:	0.0	Total Alkalinity:	196.72
SAR:	Not Reported	RSC:	Not Reported
Specific Conductance:	880	Spec. Conductance Flag:	Not Reported
Percent Sodium:	Not Reported		
Collection Remark:	Not Reported		
Reliability Remark:	RELIABILITY UNKNOWN, NOT AVAILABLE, OR NOT YET ENTERED INTO DATABASE		
Lab Name:	Not Reported		

Sample Number:	Not Reported	Sample Date:	7/30/1970
Temperature (C):	Not Reported	Sampled Aquifer Code:	Not Reported
Top of sampled interval:	Not Reported	Bottom of sampled interval:	Not Reported
Balanced/unbal Analysis:	Unbalanced	Collection Agency:	Not Reported
Silica Flag:	Not Reported	Silica MGL:	Not Reported
Calcium Flag:	Not Reported	Calcium MGL:	Not Reported
Magnesium Flag:	Not Reported	Magnesium MGL:	Not Reported
Sodium Flag:	Not Reported	Sodium MGL:	Not Reported
Potassium Flag:	Not Reported	Potassium MGL:	Not Reported
Strontium Flag:	Not Reported	Strontium MGL:	Not Reported
Carbonate MGL:	0.0	Bicarbonate MGL:	216.0
Sulfate Flag:	Not Reported	Sulfate MGL:	Not Reported
Chloride Flag:	Not Reported	Chloride MGL:	79.0
Fluoride Flag:	Not Reported	Fluoride MGL:	Not Reported
Nitrate Flag:	Not Reported	Nitrate Flag:	Not Reported
pH Flag:	Not Reported	pH:	7.9
Total Dissolved Fluids:	Not Reported	Total Hardness:	Not Reported
Phenol Alkalinity:	0.0	Total Alkalinity:	177.05
SAR:	Not Reported	RSC:	Not Reported
Specific Conductance:	583	Spec. Conductance Flag:	Not Reported
Percent Sodium:	Not Reported		
Collection Remark:	Not Reported		
Reliability Remark:	RELIABILITY UNKNOWN, NOT AVAILABLE, OR NOT YET ENTERED INTO DATABASE		
Lab Name:	Not Reported		

Sample Number:	Not Reported	Sample Date:	4/7/1971
Temperature (C):	26	Sampled Aquifer Code:	Not Reported
Top of sampled interval:	Not Reported	Bottom of sampled interval:	Not Reported
Balanced/unbal Analysis:	Unbalanced	Collection Agency:	Not Reported
Silica Flag:	Not Reported	Silica MGL:	Not Reported
Calcium Flag:	Not Reported	Calcium MGL:	Not Reported
Magnesium Flag:	Not Reported	Magnesium MGL:	Not Reported
Sodium Flag:	Not Reported	Sodium MGL:	Not Reported
Potassium Flag:	Not Reported	Potassium MGL:	Not Reported
Strontium Flag:	Not Reported	Strontium MGL:	Not Reported
Carbonate MGL:	0.0	Bicarbonate MGL:	240.0
Sulfate Flag:	Not Reported	Sulfate MGL:	Not Reported
Chloride Flag:	Not Reported	Chloride MGL:	160.0
Fluoride Flag:	Not Reported	Fluoride MGL:	Not Reported
Nitrate Flag:	Not Reported	Nitrate Flag:	Not Reported
pH Flag:	Not Reported	pH:	7.4
Total Dissolved Fluids:	Not Reported	Total Hardness:	Not Reported
Phenol Alkalinity:	0.0	Total Alkalinity:	196.72
SAR:	Not Reported	RSC:	Not Reported
Specific Conductance:	876	Spec. Conductance Flag:	Not Reported
Percent Sodium:	Not Reported		
Collection Remark:	Not Reported		
Reliability Remark:	RELIABILITY UNKNOWN, NOT AVAILABLE, OR NOT YET ENTERED INTO DATABASE		
Lab Name:	Not Reported		

GEOCHECK VERSION 2.1
STATE DATABASE WELL INFORMATION

Sample Number:	Not Reported	Sample Date:	4/5/1972
Temperature (C):	26	Sampled Aquifer Code:	Not Reported
Top of sampled interval:	Not Reported	Bottom of sampled interval:	Not Reported
Balanced/unbal Analysis:	Unbalanced	Collection Agency:	Not Reported
Silica Flag:	Not Reported	Silica MGL:	Not Reported
Calcium Flag:	Not Reported	Calcium MGL:	Not Reported
Magnesium Flag:	Not Reported	Magnesium MGL:	Not Reported
Sodium Flag:	Not Reported	Sodium MGL:	Not Reported
Potassium Flag:	Not Reported	Potassium MGL:	Not Reported
Strontium Flag:	Not Reported	Strontium MGL:	Not Reported
Carbonate MGL:	0.0	Bicarbonate MGL:	242.0
Sulfate Flag:	Not Reported	Sulfate MGL:	Not Reported
Chloride Flag:	Not Reported	Chloride MGL:	170.0
Fluoride Flag:	Not Reported	Fluoride MGL:	Not Reported
Nitrate Flag:	Not Reported	Nitrate Flag:	Not Reported
pH Flag:	Not Reported	pH:	7.4
Total Dissolved Fluids:	Not Reported	Total Hardness:	Not Reported
Phenol Alkalinity:	0.0	Total Alkalinity:	198.36
SAR:	Not Reported	RSC:	Not Reported
Specific Conductance:	929	Spec. Conductance Flag:	Not Reported
Percent Sodium:	Not Reported		
Collection Remark:	Not Reported		
Reliability Remark:	RELIABILITY UNKNOWN, NOT AVAILABLE, OR NOT YET ENTERED INTO DATABASE		
Lab Name:	Not Reported		

Sample Number:	Not Reported	Sample Date:	2/19/1974
Temperature (C):	27	Sampled Aquifer Code:	Not Reported
Top of sampled interval:	Not Reported	Bottom of sampled interval:	Not Reported
Balanced/unbal Analysis:	Unbalanced	Collection Agency:	Not Reported
Silica Flag:	Not Reported	Silica MGL:	Not Reported
Calcium Flag:	Not Reported	Calcium MGL:	Not Reported
Magnesium Flag:	Not Reported	Magnesium MGL:	Not Reported
Sodium Flag:	Not Reported	Sodium MGL:	Not Reported
Potassium Flag:	Not Reported	Potassium MGL:	Not Reported
Strontium Flag:	Not Reported	Strontium MGL:	Not Reported
Carbonate MGL:	0.0	Bicarbonate MGL:	240.0
Sulfate Flag:	Not Reported	Sulfate MGL:	Not Reported
Chloride Flag:	Not Reported	Chloride MGL:	160.0
Fluoride Flag:	Not Reported	Fluoride MGL:	Not Reported
Nitrate Flag:	Not Reported	Nitrate Flag:	Not Reported
pH Flag:	Not Reported	pH:	7.5
Total Dissolved Fluids:	Not Reported	Total Hardness:	Not Reported
Phenol Alkalinity:	0.0	Total Alkalinity:	196.72
SAR:	Not Reported	RSC:	Not Reported
Specific Conductance:	931	Spec. Conductance Flag:	Not Reported
Percent Sodium:	Not Reported		
Collection Remark:	Not Reported		
Reliability Remark:	RELIABILITY UNKNOWN, NOT AVAILABLE, OR NOT YET ENTERED INTO DATABASE		
Lab Name:	Not Reported		

GEOCHECK VERSION 2.1
STATE DATABASE WELL INFORMATION

Sample Number:	Not Reported	Sample Date:	2/6/1975
Temperature (C):	26	Sampled Aquifer Code:	Not Reported
Top of sampled interval:	Not Reported	Bottom of sampled interval:	Not Reported
Balanced/unbal Analysis:	Unbalanced	Collection Agency:	Not Reported
Silica Flag:	Not Reported	Silica MGL:	Not Reported
Calcium Flag:	Not Reported	Calcium MGL:	Not Reported
Magnesium Flag:	Not Reported	Magnesium MGL:	Not Reported
Sodium Flag:	Not Reported	Sodium MGL:	Not Reported
Potassium Flag:	Not Reported	Potassium MGL:	Not Reported
Strontium Flag:	Not Reported	Strontium MGL:	Not Reported
Carbonate MGL:	0.0	Bicarbonate MGL:	246.0
Sulfate Flag:	Not Reported	Sulfate MGL:	16.0
Chloride Flag:	Not Reported	Chloride MGL:	160.0
Fluoride Flag:	Not Reported	Fluoride MGL:	Not Reported
Nitrate Flag:	Not Reported	Nitrate Flag:	Not Reported
pH Flag:	Not Reported	pH:	7.4
Total Dissolved Fluids:	Not Reported	Total Hardness:	Not Reported
Phenol Alkalinity:	0.0	Total Alkalinity:	201.64
SAR:	Not Reported	RSC:	Not Reported
Specific Conductance:	911	Spec. Conductance Flag:	Not Reported
Percent Sodium:	Not Reported		
Collection Remark:	Not Reported		
Reliability Remark:	RELIABILITY UNKNOWN, NOT AVAILABLE, OR NOT YET ENTERED INTO DATABASE		
Lab Name:	Not Reported		

Sample Number:	Not Reported	Sample Date:	5/17/1977
Temperature (C):	26	Sampled Aquifer Code:	Not Reported
Top of sampled interval:	Not Reported	Bottom of sampled interval:	Not Reported
Balanced/unbal Analysis:	Unbalanced	Collection Agency:	Not Reported
Silica Flag:	Not Reported	Silica MGL:	Not Reported
Calcium Flag:	Not Reported	Calcium MGL:	Not Reported
Magnesium Flag:	Not Reported	Magnesium MGL:	Not Reported
Sodium Flag:	Not Reported	Sodium MGL:	Not Reported
Potassium Flag:	Not Reported	Potassium MGL:	Not Reported
Strontium Flag:	Not Reported	Strontium MGL:	Not Reported
Carbonate MGL:	0.0	Bicarbonate MGL:	260.0
Sulfate Flag:	Not Reported	Sulfate MGL:	14.0
Chloride Flag:	Not Reported	Chloride MGL:	150.0
Fluoride Flag:	Not Reported	Fluoride MGL:	Not Reported
Nitrate Flag:	Not Reported	Nitrate Flag:	Not Reported
pH Flag:	Not Reported	pH:	7.7
Total Dissolved Fluids:	Not Reported	Total Hardness:	Not Reported
Phenol Alkalinity:	0.0	Total Alkalinity:	213.11
SAR:	Not Reported	RSC:	Not Reported
Specific Conductance:	890	Spec. Conductance Flag:	Not Reported
Percent Sodium:	Not Reported		
Collection Remark:	Not Reported		
Reliability Remark:	RELIABILITY UNKNOWN, NOT AVAILABLE, OR NOT YET ENTERED INTO DATABASE		
Lab Name:	Not Reported		

GEOCHECK VERSION 2.1
STATE DATABASE WELL INFORMATION

Sample Number:	Not Reported	Sample Date:	1/23/1978
Temperature (C):	25	Sampled Aquifer Code:	Not Reported
Top of sampled interval:	Not Reported	Bottom of sampled interval:	Not Reported
Balanced/unbal Analysis:	Unbalanced	Collection Agency:	Not Reported
Silica Flag:	Not Reported	Silica MGL:	Not Reported
Calcium Flag:	Not Reported	Calcium MGL:	Not Reported
Magnesium Flag:	Not Reported	Magnesium MGL:	Not Reported
Sodium Flag:	Not Reported	Sodium MGL:	Not Reported
Potassium Flag:	Not Reported	Potassium MGL:	Not Reported
Strontium Flag:	Not Reported	Strontium MGL:	Not Reported
Carbonate MGL:	0.0	Bicarbonate MGL:	250.0
Sulfate Flag:	Not Reported	Sulfate MGL:	13.0
Chloride Flag:	Not Reported	Chloride MGL:	160.0
Fluoride Flag:	Not Reported	Fluoride MGL:	Not Reported
Nitrate Flag:	Not Reported	Nitrate Flag:	Not Reported
pH Flag:	Not Reported	pH:	8.0
Total Dissolved Fluids:	Not Reported	Total Hardness:	Not Reported
Phenol Alkalinity:	0.0	Total Alkalinity:	204.92
SAR:	Not Reported	RSC:	Not Reported
Specific Conductance:	935	Spec. Conductance Flag:	Not Reported
Percent Sodium:	Not Reported		
Collection Remark:	Not Reported		
Reliability Remark:	RELIABILITY UNKNOWN, NOT AVAILABLE, OR NOT YET ENTERED INTO DATABASE		
Lab Name:	Not Reported		

Sample Number:	Not Reported	Sample Date:	2/28/1978
Temperature (C):	26	Sampled Aquifer Code:	Not Reported
Top of sampled interval:	Not Reported	Bottom of sampled interval:	Not Reported
Balanced/unbal Analysis:	Unbalanced	Collection Agency:	Not Reported
Silica Flag:	Not Reported	Silica MGL:	Not Reported
Calcium Flag:	Not Reported	Calcium MGL:	Not Reported
Magnesium Flag:	Not Reported	Magnesium MGL:	Not Reported
Sodium Flag:	Not Reported	Sodium MGL:	Not Reported
Potassium Flag:	Not Reported	Potassium MGL:	Not Reported
Strontium Flag:	Not Reported	Strontium MGL:	Not Reported
Carbonate MGL:	0.0	Bicarbonate MGL:	270.0
Sulfate Flag:	Not Reported	Sulfate MGL:	12.0
Chloride Flag:	Not Reported	Chloride MGL:	150.0
Fluoride Flag:	Not Reported	Fluoride MGL:	Not Reported
Nitrate Flag:	Not Reported	Nitrate Flag:	Not Reported
pH Flag:	Not Reported	pH:	7.6
Total Dissolved Fluids:	Not Reported	Total Hardness:	Not Reported
Phenol Alkalinity:	0.0	Total Alkalinity:	221.31
SAR:	Not Reported	RSC:	Not Reported
Specific Conductance:	934	Spec. Conductance Flag:	Not Reported
Percent Sodium:	Not Reported		
Collection Remark:	Not Reported		
Reliability Remark:	RELIABILITY UNKNOWN, NOT AVAILABLE, OR NOT YET ENTERED INTO DATABASE		
Lab Name:	Not Reported		

Sample Number:	Not Reported	Sample Date:	3/11/1981
Temperature (C):	26	Sampled Aquifer Code:	Not Reported
Top of sampled interval:	Not Reported	Bottom of sampled interval:	Not Reported
Balanced/unbal Analysis:	Unbalanced	Collection Agency:	Not Reported
Silica Flag:	Not Reported	Silica MGL:	Not Reported
Calcium Flag:	Not Reported	Calcium MGL:	Not Reported
Magnesium Flag:	Not Reported	Magnesium MGL:	Not Reported
Sodium Flag:	Not Reported	Sodium MGL:	Not Reported
Potassium Flag:	Not Reported	Potassium MGL:	Not Reported
Strontium Flag:	Not Reported	Strontium MGL:	Not Reported
Carbonate MGL:	0.0	Bicarbonate MGL:	Not Reported
Sulfate Flag:	Not Reported	Sulfate MGL:	12.0
Chloride Flag:	Not Reported	Chloride MGL:	180.0
Fluoride Flag:	Not Reported	Fluoride MGL:	Not Reported
Nitrate Flag:	Not Reported	Nitrate Flag:	Not Reported
pH Flag:	Not Reported	pH:	7.8
Total Dissolved Fluids:	Not Reported	Total Hardness:	Not Reported
Phenol Alkalinity:	Not Reported	Total Alkalinity:	208.0
SAR:	Not Reported	RSC:	Not Reported
Specific Conductance:	916	Spec. Conductance Flag:	Not Reported
Percent Sodium:	Not Reported		
Collection Remark:	Not Reported		

Reliability Remark: RELIABILITY UNKNOWN, NOT AVAILABLE, OR NOT YET ENTERED INTO DATABASE
Lab Name: Not Reported

Water Level Information::

Measurement Number: 01
Depth from land surface: -259.39 Measurement Date: 6/27/1967
Visit Mark: Publishable - water-level is indicative of aquifer's piezometric surface
Measurement Method: Steel Tape Measuring Agency: U.S. Geological Survey
Remark: MEASUREMENT GOOD. NO UNUSUAL CONDITIONS NOTED AT OR NEAR WELL SITE

Measurement Number: 01
Depth from land surface: -273.0 Measurement Date: 9/14/1967
Visit Mark: Publishable - water-level is indicative of aquifer's piezometric surface
Measurement Method: Air Line Measuring Agency: U.S. Geological Survey
Remark: MEASUREMENT GOOD. NO UNUSUAL CONDITIONS NOTED AT OR NEAR WELL SITE

Measurement Number: 01
Depth from land surface: -266.0 Measurement Date: 3/4/1968
Visit Mark: Publishable - water-level is indicative of aquifer's piezometric surface
Measurement Method: Air Line Measuring Agency: U.S. Geological Survey
Remark: MEASUREMENT GOOD. NO UNUSUAL CONDITIONS NOTED AT OR NEAR WELL SITE

Measurement Number: 01
Depth from land surface: -268.41 Measurement Date: 3/6/1969
Visit Mark: Publishable - water-level is indicative of aquifer's piezometric surface
Measurement Method: Steel Tape Measuring Agency: U.S. Geological Survey
Remark: MEASUREMENT GOOD. NO UNUSUAL CONDITIONS NOTED AT OR NEAR WELL SITE

Measurement Number: 01
Depth from land surface: -268.74 Measurement Date: 2/6/1973
Visit Mark: Publishable - water-level is indicative of aquifer's piezometric surface
Measurement Method: Steel Tape Measuring Agency: U.S. Geological Survey
Remark: MEASUREMENT GOOD. NO UNUSUAL CONDITIONS NOTED AT OR NEAR WELL SITE

Measurement Number: 01
Depth from land surface: -350.7 Measurement Date: 9/11/1974
Visit Mark: Publishable - water-level is indicative of aquifer's piezometric surface
Measurement Method: Steel Tape Measuring Agency: U.S. Geological Survey
Remark: MEASUREMENT GOOD. NO UNUSUAL CONDITIONS NOTED AT OR NEAR WELL SITE

Measurement Number: 01
Depth from land surface: -344.4 Measurement Date: 9/11/1975
Visit Mark: Publishable - water-level is indicative of aquifer's piezometric surface
Measurement Method: Steel Tape Measuring Agency: U.S. Geological Survey
Remark: MEASUREMENT GOOD. NO UNUSUAL CONDITIONS NOTED AT OR NEAR WELL SITE

Measurement Number: 01
Depth from land surface: -354.56 Measurement Date: 9/2/1977
Visit Mark: Publishable - water-level is indicative of aquifer's piezometric surface
Measurement Method: Steel Tape Measuring Agency: U.S. Geological Survey
Remark: MEASUREMENT GOOD. NO UNUSUAL CONDITIONS NOTED AT OR NEAR WELL SITE

Measurement Number: 01
Depth from land surface: -298.2 Measurement Date: 1/23/1978
Visit Mark: Publishable - water-level is indicative of aquifer's piezometric surface
Measurement Method: Steel Tape Measuring Agency: U.S. Geological Survey
Remark: MEASUREMENT GOOD. NO UNUSUAL CONDITIONS NOTED AT OR NEAR WELL SITE

Measurement Number: 01
Depth from land surface: -308.46 Measurement Date: 1/11/1979
Visit Mark: Publishable - water-level is indicative of aquifer's piezometric surface
Measurement Method: Steel Tape Measuring Agency: U.S. Geological Survey
Remark: MEASUREMENT GOOD. NO UNUSUAL CONDITIONS NOTED AT OR NEAR WELL SITE

Measurement Number: 01
Depth from land surface: -288.0 Measurement Date: 1/16/1980
Visit Mark: Publishable - water-level is indicative of aquifer's piezometric surface
Measurement Method: Steel Tape Measuring Agency: U.S. Geological Survey
Remark: MEASUREMENT GOOD. NO UNUSUAL CONDITIONS NOTED AT OR NEAR WELL SITE

Measurement Number: 01
Depth from land surface: -314.73 Measurement Date: 1/6/1982
Visit Mark: Publishable - water-level is indicative of aquifer's piezometric surface
Measurement Method: Steel Tape Measuring Agency: U.S. Geological Survey
Remark: MEASUREMENT GOOD. NO UNUSUAL CONDITIONS NOTED AT OR NEAR WELL SITE

Measurement Number: 01
Depth from land surface: -309.35 Measurement Date: 1/28/1983
Visit Mark: Publishable - water-level is indicative of aquifer's piezometric surface
Measurement Method: Steel Tape Measuring Agency: U.S. Geological Survey
Remark: MEASUREMENT GOOD. NO UNUSUAL CONDITIONS NOTED AT OR NEAR WELL SITE

Measurement Number: 01
Depth from land surface: -297.88 Measurement Date: 1/6/1984
Visit Mark: Publishable - water-level is indicative of aquifer's piezometric surface
Measurement Method: Steel Tape Measuring Agency: U.S. Geological Survey
Remark: MEASUREMENT GOOD. NO UNUSUAL CONDITIONS NOTED AT OR NEAR WELL SITE

Measurement Number: 01
Depth from land surface: -314.8 Measurement Date: 1/28/1985
Visit Mark: Publishable - water-level is indicative of aquifer's piezometric surface
Measurement Method: Steel Tape Measuring Agency: U.S. Geological Survey
Remark: MEASUREMENT GOOD. NO UNUSUAL CONDITIONS NOTED AT OR NEAR WELL SITE

Infrequent Constituent Information::

Sample Number: 1 Storet Number: 01020
Sample Flag: Not Reported Sample Date: 6/27/1967
Constituent Value: 100. Confidence (+ or -): Not Reported
Storet Code Description: BORON, DISSOLVED (UG/L AS B)
Constituent Name: BORON Unit of Measurement: UG/L

Sample Number: 1 Storet Number: 01045
Sample Flag: Not Reported Sample Date: 6/27/1967
Constituent Value: 100. Confidence (+ or -): Not Reported
Storet Code Description: IRON, TOTAL (UG/L AS FE)
Constituent Name: IRON Unit of Measurement: UG/L

Sample Number: 1 | Storet Number: 01055
Sample Flag: Not Reported | Sample Date: 6/27/1967
Constituent Value: 0. | Confidence (+ or -): Not Reported
Storet Code Description: MANGANESE, TOTAL (UG/L AS MN)
Constituent Name: MANGNESE | Unit of Measurement: UG/L

Sample Number: 1 | Storet Number: 00900
Sample Flag: Not Reported | Sample Date: 4/2/1968
Constituent Value: 124 | Confidence (+ or -): Not Reported
Storet Code Description: HARDNESS, TOTAL (MG/L AS CACO3)
Constituent Name: TOT HARD | Unit of Measurement: MG/L

Sample Number: 1 | Storet Number: 00900
Sample Flag: Not Reported | Sample Date: 2/19/1969
Constituent Value: 130 | Confidence (+ or -): Not Reported
Storet Code Description: HARDNESS, TOTAL (MG/L AS CACO3)
Constituent Name: TOT HARD | Unit of Measurement: MG/L

Sample Number: 1 | Storet Number: 00900
Sample Flag: Not Reported | Sample Date: 5/16/1969
Constituent Value: 133 | Confidence (+ or -): Not Reported
Storet Code Description: HARDNESS, TOTAL (MG/L AS CACO3)
Constituent Name: TOT HARD | Unit of Measurement: MG/L

Sample Number: 1 | Storet Number: 00900
Sample Flag: Not Reported | Sample Date: 8/4/1969
Constituent Value: 130 | Confidence (+ or -): Not Reported
Storet Code Description: HARDNESS, TOTAL (MG/L AS CACO3)
Constituent Name: TOT HARD | Unit of Measurement: MG/L

Sample Number: 1 | Storet Number: 00900
Sample Flag: Not Reported | Sample Date: 7/30/1970
Constituent Value: 110 | Confidence (+ or -): Not Reported
Storet Code Description: HARDNESS, TOTAL (MG/L AS CACO3)
Constituent Name: TOT HARD | Unit of Measurement: MG/L

Sample Number: 1 | Storet Number: 00900
Sample Flag: Not Reported | Sample Date: 4/7/1971
Constituent Value: 140 | Confidence (+ or -): Not Reported
Storet Code Description: HARDNESS, TOTAL (MG/L AS CACO3)
Constituent Name: TOT HARD | Unit of Measurement: MG/L

Sample Number: 1 | Storet Number: 00900
Sample Flag: Not Reported | Sample Date: 4/5/1972
Constituent Value: 130 | Confidence (+ or -): Not Reported
Storet Code Description: HARDNESS, TOTAL (MG/L AS CACO3)
Constituent Name: TOT HARD | Unit of Measurement: MG/L

Sample Number: 1 | Storet Number: 00900
Sample Flag: Not Reported | Sample Date: 2/19/1974
Constituent Value: 140 | Confidence (+ or -): Not Reported
Storet Code Description: HARDNESS, TOTAL (MG/L AS CACO3)
Constituent Name: TOT HARD | Unit of Measurement: MG/L

Remarks:

330 ft of screen between 515 and 1215 ft. Reported yield 2409 gpm with 87 ft drawdown when drilled. test hole drilled to 1915 ft.

GEOCHECK VERSION 2.1
STATE DATABASE WELL INFORMATION

Well Within >2 Miles of Target Property (Southern Quadrant)

Well Number:	6521929		
Owner:	TEXAS BRINE CORP.		
Driller:	MICKELSON WELL NO. 10		
Basin:	San Jacinto River		
Accuracy of Coordinates:	Accurate to +/- 1 second		
Latitude:	952430	Longitude:	293853
Info Source:	Texas Water Development Board	Previous Well Number:	Not Reported
FIPS County Code:	201	County:	Harris
Zone:	1	Region Number:	8
Aquifer Code:	112CHCT	Users Code Economics:	Not Reported
Ground Elevation AMSL:	61	Elevation Method:	Interpolated from topographic maps
Date Drilled:	1973	Well Type:	Withdrawal of Water
Well Depth (ft):	455	Source of Depth Data:	Not Reported
Type of Lift:	Turbine Pump	Type of Power:	Not Reported
Horsepower:	60.0	Tertiary Water Use:	Not Reported
Primary Water Use:	Industrial	Secondary Water Use:	Not Reported
Well Schedule in file:	Not Reported	Construction Method:	Hydraulic Rotary
Method of Finish:	Screen	Lithological Log Type:	Not Reported
Casing Material:	Steel	Screen Material:	Not Reported
Lithological Interpreter:	Not Reported	Interpretation Date:	Not Reported
Qlty Analysis Available:	Not Reported	Level Data Available:	Not Reported
Data Collection Date:	Not Reported	Reporting Agency:	Not Reported
Water Logs Available:	Not Reported		
Other Data Available:	Not Reported		
Aquifer:	CHICOT AQUIFER		

Well Within >2 Miles of Target Property (Western Quadrant)

Well Number:	6521815		
Owner:	Marathon Paving		
Driller:	O'Day Drlg		
Basin:	San Jacinto River		
Accuracy of Coordinates:	Not Reported		
Latitude:	952531	Longitude:	293936
Info Source:	Texas Water Development Board	Previous Well Number:	Not Reported
FIPS County Code:	201	County:	Harris
Zone:	1	Region Number:	8
Aquifer Code:	112CHCT	Users Code Economics:	Not Reported
Ground Elevation AMSL:	60	Elevation Method:	Interpolated from topographic maps
Date Drilled:	1981	Well Type:	Withdrawal of Water
Well Depth (ft):	301	Source of Depth Data:	Driller's log/Well report
Type of Lift:	Not Reported	Type of Power:	NO POWER SOURCE
Horsepower:	Not Reported	Tertiary Water Use:	Not Reported
Primary Water Use:	Industrial	Secondary Water Use:	Not Reported
Well Schedule in file:	Not Reported	Construction Method:	Not Reported
Method of Finish:	Not Reported	Lithological Log Type:	Not Reported
Casing Material:	Not Reported	Screen Material:	Not Reported
Lithological Interpreter:	Not Reported	Interpretation Date:	Not Reported
Qlty Analysis Available:	No	Level Data Available:	Miscellaneous water-level measurements
Data Collection Date:	12 1988	Reporting Agency:	U.S. Geological Survey
Water Logs Available:	Drillers		
Other Data Available:	Not Reported		
Aquifer:	CHICOT AQUIFER		

Water Level Information::

Measurement Number:	01		
Depth from land surface:	-170.0	Measurement Date:	5/20/1981
Visit Mark:	Publishable - water-level is indicative of aquifer's piezometric surface		
Measurement Method:	Unknown	Measuring Agency:	Registered Water Well Driller
Remark:	MEASUREMENT GOOD. NO UNUSUAL CONDITIONS NOTED AT OR NEAR WELL SITE		

Remarks:

Reported yield 150 gpm.

STATE OIL/GAS WELL INFORMATION:

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6843	Longitude:	-95.3933
Type:	Oil Well	American Petroleum Inst #:	42201
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Oil Well		

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6828	Longitude:	-95.3932
Type:	Oil Well	American Petroleum Inst #:	42201
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Oil Well		

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6788	Longitude:	-95.4105
Type:	Oil Well	American Petroleum Inst #:	42201 D1
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Oil Well		

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6788	Longitude:	-95.4039
Type:	Oil Well	American Petroleum Inst #:	42201
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Plugged Oil Well		

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6781	Longitude:	-95.4069
Type:	Oil Well	American Petroleum Inst #:	42201
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Plugged Oil Well		

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6781	Longitude:	-95.4088
Type:	Oil Well	American Petroleum Inst #:	42201
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Oil Well		

STATE OIL/GAS WELL INFORMATION:

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6781	Longitude:	-95.3966
Type:	Oil Well	American Petroleum Inst #:	42201
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Oil Well		

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6776	Longitude:	-95.4126
Type:	Oil Well	American Petroleum Inst #:	42201
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Plugged Oil Well		

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6773	Longitude:	-95.3996
Type:	Oil Well	American Petroleum Inst #:	42201
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Oil Well		

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6770	Longitude:	-95.4035
Type:	Oil Well	American Petroleum Inst #:	4220104854
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Plugged Oil Well		

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6769	Longitude:	-95.4010
Type:	Oil Well	American Petroleum Inst #:	4220104855
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Plugged Oil Well		

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6763	Longitude:	-95.4026
Type:	Oil Well	American Petroleum Inst #:	42201
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Oil Well		

GEOCHECK VERSION 2.1
STATE DATABASE WELL INFORMATION

STATE OIL/GAS WELL INFORMATION:

Orig Well Operator: Not Reported
Latitude: 29.6763
Type: Oil Well
Reliability of Well Spot: RRC Hardcopy Map.
Symbol: Oil Well
Current Name of Lease: Not Reported
Longitude: -95.3994
American Petroleum Inst #: 42201

Orig Well Operator: Not Reported
Latitude: 29.6762
Type: Oil Well
Reliability of Well Spot: RRC Hardcopy Map.
Symbol: Oil Well
Current Name of Lease: Not Reported
Longitude: -95.3985
American Petroleum Inst #: 42201

Orig Well Operator: Not Reported
Latitude: 29.6754
Type: Oil Well
Reliability of Well Spot: RRC Hardcopy Map.
Symbol: Oil Well
Current Name of Lease: Not Reported
Longitude: -95.4071
American Petroleum Inst #: 42201

Orig Well Operator: Not Reported
Latitude: 29.6752
Type: Oil Well
Reliability of Well Spot: RRC Hardcopy Map.
Symbol: Well Location
Current Name of Lease: Not Reported
Longitude: -95.4002
American Petroleum Inst #: 42201 D1

Orig Well Operator: Not Reported
Latitude: 29.6751
Type: Oil Well
Reliability of Well Spot: RRC Hardcopy Map.
Symbol: Oil Well
Current Name of Lease: Not Reported
Longitude: -95.3980
American Petroleum Inst #: 42201

Orig Well Operator: Not Reported
Latitude: 29.6749
Type: Oil Well
Reliability of Well Spot: RRC Hardcopy Map.
Symbol: Plugged Oil Well
Current Name of Lease: Not Reported
Longitude: -95.4010
American Petroleum Inst #: 42201

GEOCHECK VERSION 2.1
STATE DATABASE WELL INFORMATION

STATE OIL/GAS WELL INFORMATION:

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6748	Longitude:	-95.4049
Type:	Oil Well	American Petroleum Inst #:	42201
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Oil Well		

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6746	Longitude:	-95.4020
Type:	Oil Well	American Petroleum Inst #:	42201
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Oil Well		

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6746	Longitude:	-95.4030
Type:	Oil Well	American Petroleum Inst #:	42201
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Plugged Oil Well		

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6742	Longitude:	-95.3974
Type:	Oil Well	American Petroleum Inst #:	42201
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Oil Well		

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6739	Longitude:	-95.4111
Type:	Oil Well	American Petroleum Inst #:	42201
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Plugged Oil Well		

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6737	Longitude:	-95.4036
Type:	Oil Well	American Petroleum Inst #:	42201
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Plugged Oil Well		

GEOCHECK VERSION 2.1
STATE DATABASE WELL INFORMATION

STATE OIL/GAS WELL INFORMATION:

Orig Well Operator: Not Reported
Latitude: 29.6737
Type: Oil Well
Reliability of Well Spot: RRC Hardcopy Map.
Symbol: Oil Well
Current Name of Lease: Not Reported
Longitude: -95.3994
American Petroleum Inst #: 42201

Orig Well Operator: Not Reported
Latitude: 29.6737
Type: Oil Well
Reliability of Well Spot: RRC Hardcopy Map.
Symbol: Well Location
Current Name of Lease: Not Reported
Longitude: -95.4043
American Petroleum Inst #: 42201

Orig Well Operator: Not Reported
Latitude: 29.6736
Type: Oil Well
Reliability of Well Spot: RRC Hardcopy Map.
Symbol: Oil Well
Current Name of Lease: Not Reported
Longitude: -95.3973
American Petroleum Inst #: 42201

Orig Well Operator: Not Reported
Latitude: 29.6730
Type: Oil Well
Reliability of Well Spot: RRC Hardcopy Map.
Symbol: Oil Well
Current Name of Lease: Not Reported
Longitude: -95.3982
American Petroleum Inst #: 42201

Orig Well Operator: Not Reported
Latitude: 29.6729
Type: Oil Well
Reliability of Well Spot: RRC Hardcopy Map.
Symbol: Well Location
Current Name of Lease: Not Reported
Longitude: -95.4040
American Petroleum Inst #: 42201

Orig Well Operator: Not Reported
Latitude: 29.6728
Type: Oil Well
Reliability of Well Spot: RRC Hardcopy Map.
Symbol: Plugged Oil Well
Current Name of Lease: Not Reported
Longitude: -95.4057
American Petroleum Inst #: 4220181380

GEOCHECK VERSION 2.1
STATE DATABASE WELL INFORMATION

STATE OIL/GAS WELL INFORMATION:

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6727	Longitude:	-95.4050
Type:	Oil Well	American Petroleum Inst #:	42201
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Well Location		

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6727	Longitude:	-95.3971
Type:	Oil Well	American Petroleum Inst #:	42201
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Plugged Oil Well		

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6727	Longitude:	-95.4133
Type:	Oil Well	American Petroleum Inst #:	4220104848
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Plugged Oil Well		

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6727	Longitude:	-95.4016
Type:	Oil Well	American Petroleum Inst #:	4220104865
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Plugged Oil Well		

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6725	Longitude:	-95.4098
Type:	Oil Well	American Petroleum Inst #:	42201
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Oil Well		

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6724	Longitude:	-95.4044
Type:	Oil Well	American Petroleum Inst #:	42201
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Oil Well		

GEOCHECK VERSION 2.1
STATE DATABASE WELL INFORMATION

STATE OIL/GAS WELL INFORMATION:

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6722	Longitude:	-95.4000
Type:	Oil Well	American Petroleum Inst #:	42201
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Oil Well		

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6717	Longitude:	-95.3943
Type:	Oil Well	American Petroleum Inst #:	42201
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Plugged Oil Well		

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6717	Longitude:	-95.4042
Type:	Oil Well	American Petroleum Inst #:	42201 D1
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Oil Well		

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6716	Longitude:	-95.4047
Type:	Oil Well	American Petroleum Inst #:	42201
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Plugged Oil Well		

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6715	Longitude:	-95.4065
Type:	Oil Well	American Petroleum Inst #:	42201
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Dry Hole		

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6713	Longitude:	-95.3991
Type:	Oil Well	American Petroleum Inst #:	42201
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Oil Well		

GEOCHECK VERSION 2.1
STATE DATABASE WELL INFORMATION

STATE OIL/GAS WELL INFORMATION:

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6713	Longitude:	-95.3943
Type:	Oil Well	American Petroleum Inst #:	42201
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Oil Well		

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6713	Longitude:	-95.4106
Type:	Oil Well	American Petroleum Inst #:	42201
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Oil Well		

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6713	Longitude:	-95.4067
Type:	Oil Well	American Petroleum Inst #:	42201
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Plugged Oil Well		

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6711	Longitude:	-95.3960
Type:	Oil Well	American Petroleum Inst #:	42201
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Oil Well		

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6710	Longitude:	-95.3978
Type:	Oil Well	American Petroleum Inst #:	42201
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Oil Well		

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6709	Longitude:	-95.3956
Type:	Oil Well	American Petroleum Inst #:	42201
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Oil Well		

STATE OIL/GAS WELL INFORMATION:

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6709	Longitude:	-95.3971
Type:	Oil Well	American Petroleum Inst #:	42201
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Oil Well		

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6706	Longitude:	-95.3934
Type:	Oil Well	American Petroleum Inst #:	4220105220D1
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Plugged Oil Well		

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6706	Longitude:	-95.3971
Type:	Oil Well	American Petroleum Inst #:	42201
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Oil Well		

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6705	Longitude:	-95.4046
Type:	Oil Well	American Petroleum Inst #:	42201
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Plugged Oil Well		

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6704	Longitude:	-95.3985
Type:	Oil Well	American Petroleum Inst #:	42201
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Oil Well		

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6703	Longitude:	-95.3971
Type:	Oil Well	American Petroleum Inst #:	42201
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Oil Well		

STATE OIL/GAS WELL INFORMATION:

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6702	Longitude:	-95.4040
Type:	Oil Well	American Petroleum Inst #:	4220104859
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Plugged Oil Well		

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6702	Longitude:	-95.3977
Type:	Oil Well	American Petroleum Inst #:	42201
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Plugged Oil Well		

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6700	Longitude:	-95.3952
Type:	Oil Well	American Petroleum Inst #:	4220105227D1
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Plugged Oil Well		

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6697	Longitude:	-95.3990
Type:	Oil Well	American Petroleum Inst #:	42201
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Well Location		

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6694	Longitude:	-95.4002
Type:	Oil Well	American Petroleum Inst #:	42201
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Plugged Oil Well		

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6692	Longitude:	-95.3980
Type:	Oil Well	American Petroleum Inst #:	42201
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Oil Well		

GEOCHECK VERSION 2.1
STATE DATABASE WELL INFORMATION

STATE OIL/GAS WELL INFORMATION:

Orig Well Operator: Not Reported
Latitude: 29.6692
Type: Oil Well
Reliability of Well Spot: RRC Hardcopy Map.
Symbol: Plugged Oil Well
Current Name of Lease: Not Reported
Longitude: -95.4017
American Petroleum Inst #: 42201

Orig Well Operator: Not Reported
Latitude: 29.6691
Type: Oil Well
Reliability of Well Spot: RRC Hardcopy Map.
Symbol: Oil Well
Current Name of Lease: Not Reported
Longitude: -95.3988
American Petroleum Inst #: 42201

Orig Well Operator: Not Reported
Latitude: 29.6690
Type: Oil Well
Reliability of Well Spot: RRC Hardcopy Map.
Symbol: Well Location
Current Name of Lease: Not Reported
Longitude: -95.4059
American Petroleum Inst #: 42201

Orig Well Operator: Not Reported
Latitude: 29.6690
Type: Oil Well
Reliability of Well Spot: RRC Hardcopy Map.
Symbol: Dry Hole
Current Name of Lease: Not Reported
Longitude: -95.4052
American Petroleum Inst #: 42201

Orig Well Operator: Not Reported
Latitude: 29.6690
Type: Oil Well
Reliability of Well Spot: RRC Hardcopy Map.
Symbol: Plugged Oil Well
Current Name of Lease: Not Reported
Longitude: -95.4038
American Petroleum Inst #: 42201

Orig Well Operator: Not Reported
Latitude: 29.6689
Type: Oil Well
Reliability of Well Spot: RRC Hardcopy Map.
Symbol: Plugged Oil Well
Current Name of Lease: Not Reported
Longitude: -95.4019
American Petroleum Inst #: 42201

STATE OIL/GAS WELL INFORMATION:

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6687	Longitude:	-95.3886
Type:	Oil Well	American Petroleum Inst #:	42201
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Dry Hole		

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6686	Longitude:	-95.3970
Type:	Oil Well	American Petroleum Inst #:	4220181373
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Oil Well		

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6684	Longitude:	-95.4007
Type:	Oil Well	American Petroleum Inst #:	42201
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Oil Well		

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6684	Longitude:	-95.4046
Type:	Oil Well	American Petroleum Inst #:	42201
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Oil Well		

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6684	Longitude:	-95.3958
Type:	Oil Well	American Petroleum Inst #:	4220181377
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Plugged Oil Well		

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6684	Longitude:	-95.3937
Type:	Oil Well	American Petroleum Inst #:	42201
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Plugged Oil Well		

STATE OIL/GAS WELL INFORMATION:

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6683	Longitude:	-95.3976
Type:	Oil Well	American Petroleum Inst #:	42201
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Canceled/Abandoned Location		

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6681	Longitude:	-95.4015
Type:	Oil Well	American Petroleum Inst #:	42201
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Oil Well		

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6676	Longitude:	-95.3917
Type:	Oil Well	American Petroleum Inst #:	4220105219D1
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Oil Well		

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6675	Longitude:	-95.3992
Type:	Oil Well	American Petroleum Inst #:	42201
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Dry Hole		

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6671	Longitude:	-95.4054
Type:	Oil Well	American Petroleum Inst #:	42201
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Oil Well		

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6666	Longitude:	-95.4044
Type:	Oil Well	American Petroleum Inst #:	42201
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Dry Hole		

GEOCHECK VERSION 2.1
STATE DATABASE WELL INFORMATION

STATE OIL/GAS WELL INFORMATION:

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6665	Longitude:	-95.4065
Type:	Oil Well	American Petroleum Inst #:	42201
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Dry Hole		

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6664	Longitude:	-95.4068
Type:	Oil Well	American Petroleum Inst #:	42201
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Plugged Oil Well		

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6664	Longitude:	-95.3933
Type:	Oil Well	American Petroleum Inst #:	4220181374
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Plugged Oil Well		

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6663	Longitude:	-95.3958
Type:	Oil Well	American Petroleum Inst #:	4220105232
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Plugged Oil Well		

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6663	Longitude:	-95.4065
Type:	Oil Well	American Petroleum Inst #:	42201
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Dry Hole		

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6662	Longitude:	-95.4044
Type:	Oil Well	American Petroleum Inst #:	42201
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Dry Hole		

GEOCHECK VERSION 2.1
STATE DATABASE WELL INFORMATION

STATE OIL/GAS WELL INFORMATION:

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6660	Longitude:	-95.4006
Type:	Oil Well	American Petroleum Inst #:	42201
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Oil Well		

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6659	Longitude:	-95.4053
Type:	Oil Well	American Petroleum Inst #:	42201
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Dry Hole		

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6657	Longitude:	-95.3928
Type:	Oil Well	American Petroleum Inst #:	42201
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Dry Hole		

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6656	Longitude:	-95.4053
Type:	Oil Well	American Petroleum Inst #:	4220104937
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Plugged Oil Well		

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6656	Longitude:	-95.4016
Type:	Oil Well	American Petroleum Inst #:	4220130031
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Oil Well		

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6655	Longitude:	-95.3998
Type:	Oil Well	American Petroleum Inst #:	42201
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Dry Hole		

GEOCHECK VERSION 2.1
STATE DATABASE WELL INFORMATION

STATE OIL/GAS WELL INFORMATION:

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6654	Longitude:	-95.4028
Type:	Oil Well	American Petroleum Inst #:	4220181384
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Plugged Oil Well		

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6651	Longitude:	-95.3992
Type:	Oil Well	American Petroleum Inst #:	4220104988
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Canceled/Abandoned Location		

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6650	Longitude:	-95.4029
Type:	Oil Well	American Petroleum Inst #:	42201
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Dry Hole		

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6649	Longitude:	-95.3979
Type:	Oil Well	American Petroleum Inst #:	42201
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Oil Well		

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6647	Longitude:	-95.4008
Type:	Oil Well	American Petroleum Inst #:	4220104987
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Plugged Oil Well		

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6647	Longitude:	-95.4019
Type:	Oil Well	American Petroleum Inst #:	42201
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Oil Well		

STATE OIL/GAS WELL INFORMATION:

Orig Well Operator:	Not Reported	Current Name of Lease:	Not Reported
Latitude:	29.6646	Longitude:	-95.4014
Type:	Oil Well	American Petroleum Inst #:	4220181744
Reliability of Well Spot:	RRC Hardcopy Map.		
Symbol:	Plugged Oil Well		

GEOCHECK VERSION 2.1
PUBLIC WATER SUPPLY SYSTEM INFORMATION

Searched by Nearest PWS.

PWS SUMMARY:

PWS ID:	TX1011074	PWS Status:	Active	Distance from TP:	>2 Miles
Date Initiated:	June / 2077	Date Deactivated:	Not Reported	Dir relative to TP:	West
PWS Name:	L R MHP 4131 DURNESS HOUSTON, TX 77025				

Addressee / Facility: Not Reported

Facility Latitude:	29 41 30	Facility Longitude:	095 26 00
City Served:	Not Reported		
Treatment Class:	Untreated	Population Served:	Under 101 Persons

PWS currently has or has had major violation(s) or enforcement: No

EPA Waste Codes Addendum

Code	Description
D001	IGNITABLE HAZARDOUS WASTES ARE THOSE WASTES WHICH HAVE A FLASHPOINT OF LESS THAN 140 DEGREES FAHRENHEIT AS DETERMINED BY A PENSKY-MARTENS CLOSED CUP FLASH POINT TESTER. ANOTHER METHOD OF DETERMINING THE FLASH POINT OF A WASTE IS TO REVIEW THE MATERIAL SAFETY DATA SHEET, WHICH CAN BE OBTAINED FROM THE MANUFACTURER OR DISTRIBUTOR OF THE MATERIAL. LACQUER THINNER IS AN EXAMPLE OF A COMMONLY USED SOLVENT WHICH WOULD BE CONSIDERED AS IGNITABLE HAZARDOUS WASTE.
D002	A WASTE WHICH HAS A PH OF LESS THAN 2 OR GREATER THAN 12.5 IS CONSIDERED TO BE A CORROSIVE HAZARDOUS WASTE. SODIUM HYDROXIDE, A CAUSTIC SOLUTION WITH A HIGH PH, IS OFTEN USED BY INDUSTRIES TO CLEAN OR DEGREASE PARTS. HYDROCHLORIC ACID, A SOLUTION WITH A LOW PH, IS USED BY MANY INDUSTRIES TO CLEAN METAL PARTS PRIOR TO PAINTING. WHEN THESE CAUSTIC OR ACID SOLUTIONS BECOME CONTAMINATED AND MUST BE DISPOSED, THE WASTE WOULD BE A CORROSIVE HAZARDOUS WASTE.
D003	A MATERIAL IS CONSIDERED TO BE A REACTIVE HAZARDOUS WASTE IF IT IS NORMALLY UNSTABLE, REACTS VIOLENTLY WITH WATER, GENERATES TOXIC GASES WHEN EXPOSED TO WATER OR CORROSIVE MATERIALS, OR IF IT IS CAPABLE OF DETONATION OR EXPLOSION WHEN EXPOSED TO HEAT OR A FLAME. ONE EXAMPLE OF SUCH WASTE WOULD BY WASTE GUNPOWDER.
D018	BENZENE
F002	THE FOLLOWING SPENT HALOGENATED SOLVENTS: TETRACHLOROETHYLENE, METHYLENE CHLORIDE, TRICHLOROETHYLENE, 1,1,1-TRICHLOROETHANE, CHLOROBENZENE, 1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE, ORTHO-DICHLOROBENZENE, TRICHLOROFLUOROMETHANE, AND 1,1,2-TRICHLOROETHANE; ALL SPENT SOLVENT MIXTURES/BLENDS CONTAINING, BEFORE USE, A TOTAL OF TEN PERCENT OR MORE (BY VOLUME) OF ONE OR MORE OF THE ABOVE HALOGENATED SOLVENTS OR THOSE LISTED IN F001, F004, OR F005, AND STILL BOTTOMS FROM THE RECOVERY OF THESE SPENT SOLVENTS AND SPENT SOLVENT MIXTURES.
F003	THE FOLLOWING SPENT NON-HALOGENATED SOLVENTS: XYLENE, ACETONE, ETHYL ACETATE, ETHYL BENZENE, ETHYL ETHER, METHYL ISOBUTYL KETONE, N-BUTYL ALCOHOL, CYCLOHEXANONE, AND METHANOL; ALL SPENT SOLVENT MIXTURES/BLENDS CONTAINING, BEFORE USE, ONLY THE ABOVE SPENT NON-HALOGENATED SOLVENTS; AND ALL SPENT SOLVENT MIXTURES/BLENDS CONTAINING, BEFORE USE, ONE OR MORE OF THE ABOVE NON-HALOGENATED SOLVENTS, AND, A TOTAL OF TEN PERCENT OR MORE (BY VOLUME) OF ONE OR MORE OF THOSE SOLVENTS LISTED IN F001, F002, F004, AND F005, AND STILL BOTTOMS FROM THE RECOVERY OF THESE SPENT SOLVENTS AND SPENT SOLVENT MIXTURES.
F005	THE FOLLOWING SPENT NON-HALOGENATED SOLVENTS: TOLUENE, METHYL ETHYL KETONE, CARBON DISULFIDE, ISOBUTANOL, PYRIDINE, BENZENE, 2-ETHOXYETHANOL, AND 2-NITROPROPANE; ALL SPENT SOLVENT MIXTURES/BLENDS CONTAINING, BEFORE USE, A TOTAL OF TEN PERCENT OR MORE (BY VOLUME) OF ONE OR MORE OF THE ABOVE NON-HALOGENATED SOLVENTS OR THOSE SOLVENTS LISTED IN F001, F002, OR F004; AND STILL BOTTOMS FROM THE RECOVERY OF THESE SPENT SOLVENTS AND SPENT SOLVENT MIXTURES.
U122	FORMALDEHYDE
U147	2,5-FURANDIONE

EPA Waste Codes Addendum

Code	Description
U147	MALEIC ANHYDRIDE
U154	METHANOL (I)
U154	METHYL ALCOHOL (I)
U190	1,3-ISOBENZOFURANDIONE
U190	PHTHALIC ANHYDRIDE

GOVERNMENT RECORDS SEARCHED / DATA CURRENCY TRACKING

To maintain currency of the following federal and state databases, EDR contacts the appropriate governmental agency on a monthly or quarterly basis, as required.

Elapsed ASTM days: Provides confirmation that this EDR report meets or exceeds the 90-day updating requirement of the ASTM standard.

FEDERAL ASTM STANDARD RECORDS

NPL: National Priority List
Source: EPA
Telephone: N/A
National Priorities List (Superfund). The NPL is a subset of CERCLIS and identifies over 1,200 sites for priority cleanup under the Superfund Program. NPL sites may encompass relatively large areas. As such, EDR provides polygon coverage for over 1,000 NPL site boundaries produced by EPA's Environmental Photographic Interpretation Center (EPIC).

Date of Government Version: 07/22/99
Date Made Active at EDR: 09/10/99
Database Release Frequency: Semi-Annually
Date of Data Arrival at EDR: 08/05/99
Elapsed ASTM days: 36
Date of Last EDR Contact: 11/08/99

DELISTED NPL: NPL Deletions
Source: EPA
Telephone: N/A
The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) establishes the criteria that the EPA uses to delete sites from the NPL. In accordance with 40 CFR 300.425.(e), sites may be deleted from the NPL where no further response is appropriate.

Date of Government Version: 06/24/99
Date Made Active at EDR: 09/10/99
Database Release Frequency: Semi-Annually
Date of Data Arrival at EDR: 08/10/99
Elapsed ASTM days: 31
Date of Last EDR Contact: 11/08/99

CERCLIS: Comprehensive Environmental Response, Compensation, and Liability Information System
Source: EPA
Telephone: 703-413-0223
CERCLIS contains data on potentially hazardous waste sites that have been reported to the USEPA by states, municipalities, private companies and private persons, pursuant to Section 103 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). CERCLIS contains sites which are either proposed to or on the National Priorities List (NPL) and sites which are in the screening and assessment phase for possible inclusion on the NPL.

Date of Government Version: 08/26/99
Date Made Active at EDR: 11/11/99
Database Release Frequency: Quarterly
Date of Data Arrival at EDR: 08/30/99
Elapsed ASTM days: 73
Date of Last EDR Contact: 11/29/99

CERCLIS-NFRAP: No Further Remedial Action Planned
Source: EPA
Telephone: 703-413-0223
As of February 1995, CERCLIS sites designated "No Further Remedial Action Planned" (NFRAP) have been removed from CERCLIS. NFRAP sites may be sites where, following an initial investigation, no contamination was found, contamination was removed quickly without the need for the site to be placed on the NPL, or the contamination was not serious enough to require Federal Superfund action or NPL consideration. EPA has removed approximately 25,000 NFRAP sites to lift the unintended barriers to the redevelopment of these properties and has archived them as historical records so EPA does not needlessly repeat the investigations in the future. This policy change is part of the EPA's Brownfields Redevelopment Program to help cities, states, private investors and affected citizens to promote economic redevelopment of unproductive urban sites.

Date of Government Version: 08/26/99
Date Made Active at EDR: 11/11/99
Database Release Frequency: Quarterly
Date of Data Arrival at EDR: 08/30/99
Elapsed ASTM days: 73
Date of Last EDR Contact: 11/29/99

CORRACTS: Corrective Action Report
Source: EPA
Telephone: 800-424-9346
CORRACTS identifies hazardous waste handlers with RCRA corrective action activity.

Date of Government Version: 09/07/99
Date Made Active at EDR: 10/28/99
Database Release Frequency: Semi-Annually
Date of Data Arrival at EDR: 09/13/99
Elapsed ASTM days: 45
Date of Last EDR Contact: 12/13/99

RCRIS: Resource Conservation and Recovery Information System
Source: EPA/NTIS
Telephone: 800-424-9346
Resource Conservation and Recovery Information System. RCRIS includes selective information on sites which generate, transport, store, treat and/or dispose of hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA).

Date of Government Version: 09/01/99
Date Made Active at EDR: 11/17/99
Database Release Frequency: Semi-Annually
Date of Data Arrival at EDR: 10/06/99
Elapsed ASTM days: 42
Date of Last EDR Contact: 01/03/00

ERNS: Emergency Response Notification System
Source: EPA/NTIS
Telephone: 202-260-2342
Emergency Response Notification System. ERNS records and stores information on reported releases of oil and hazardous substances.

Date of Government Version: 01/06/00
Date Made Active at EDR: 02/08/00
Database Release Frequency: Quarterly
Date of Data Arrival at EDR: 01/31/00
Elapsed ASTM days: 8
Date of Last EDR Contact: 11/01/99

FEDERAL ASTM SUPPLEMENTAL RECORDS

BRS: Biennial Reporting System
Source: EPA/NTIS
Telephone: 800-424-9346
The Biennial Reporting System is a national system administered by the EPA that collects data on the generation and management of hazardous waste. BRS captures detailed data from two groups: Large Quantity Generators (LQG) and Treatment, Storage, and Disposal Facilities.

Date of Government Version: 12/31/97
Database Release Frequency: Biennially
Date of Last EDR Contact: 12/20/99
Date of Next Scheduled EDR Contact: 03/20/00

CONSENT: Superfund (CERCLA) Consent Decrees
Source: EPA Regional Offices
Telephone: Varies
Major legal settlements that establish responsibility and standards for cleanup at NPL (Superfund) sites. Released periodically by United States District Courts after settlement by parties to litigation matters.

Date of Government Version: Varies
Database Release Frequency: Varies
Date of Last EDR Contact: Varies
Date of Next Scheduled EDR Contact: N/A

ROD: Records Of Decision
Source: NTIS
Telephone: 703-416-0223
Record of Decision. ROD documents mandate a permanent remedy at an NPL (Superfund) site containing technical and health information to aid in the cleanup.

Date of Government Version: 01/31/99
Database Release Frequency: Annually
Date of Last EDR Contact: 01/10/00
Date of Next Scheduled EDR Contact: 04/10/00

FINDS: Facility Index System/Facility Identification Initiative Program Summary Report
Source: EPA
Telephone: N/A
Facility Index System. FINDS contains both facility information and 'pointers' to other sources that contain more detail. EDR includes the following FINDS databases in this report: PCS (Permit Compliance System), AIRS (Aerometric Information Retrieval System), DOCKET (Enforcement Docket used to manage and track information on civil judicial enforcement cases for all environmental statutes), FURS (Federal Underground Injection Control), C-DOCKET (Criminal Docket System used to track criminal enforcement actions for all environmental statutes), FFIS (Federal Facilities Information System), STATE (State Environmental Laws and Statutes), and PADS (PCB Activity Data System).

Date of Government Version: 10/13/99 — Date of Last EDR Contact: 01/12/00
Database Release Frequency: Quarterly — Date of Next Scheduled EDR Contact: 04/10/00

HMIRS: Hazardous Materials Information Reporting System
Source: U.S. Department of Transportation
Telephone: 202-366-4526
Hazardous Materials Incident Report System. HMIRS contains hazardous material spill incidents reported to DOT.

Date of Government Version: 06/30/99 — Date of Last EDR Contact: 10/28/99
Database Release Frequency: Annually — Date of Next Scheduled EDR Contact: 01/24/00

MLTS: Material Licensing Tracking System
Source: Nuclear Regulatory Commission
Telephone: 301-415-7169
MLTS is maintained by the Nuclear Regulatory Commission and contains a list of approximately 8,100 sites which possess or use radioactive materials and which are subject to NRC licensing requirements. To maintain currency, EDR contacts the Agency on a quarterly basis.

Date of Government Version: 10/29/99 — Date of Last EDR Contact: 01/10/00
Database Release Frequency: Quarterly — Date of Next Scheduled EDR Contact: 04/10/00

MINES: Mines Master Index File
Source: Department of Labor, Mine Safety and Health Administration
Telephone: 303-231-5959

Date of Government Version: 08/01/98 — Date of Last EDR Contact: 01/03/00
Database Release Frequency: Semi-Annually — Date of Next Scheduled EDR Contact: 04/03/00

NPL LIENS: Federal Superfund Liens
Source: EPA
Telephone: 205-564-4267
Federal Superfund Liens. Under the authority granted the USEPA by the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) of 1980, the USEPA has the authority to file liens against real property in order to recover remedial action expenditures or when the property owner receives notification of potential liability. USEPA compiles a listing of filed notices of Superfund Liens.

Date of Government Version: 10/15/91 — Date of Last EDR Contact: 11/24/99
Database Release Frequency: No Update Planned — Date of Next Scheduled EDR Contact: 02/21/00

PADS: PCB Activity Database System
Source: EPA
Telephone: 202-260-3936
PCB Activity Database. PADS Identifies generators, transporters, commercial storers and/or brokers and disposers of PCB's who are required to notify the EPA of such activities.

Date of Government Version: 09/22/97 — Date of Last EDR Contact: 11/09/99
Database Release Frequency: No Update Planned — Date of Next Scheduled EDR Contact: 02/14/00

RAATS: RCRA Administrative Action Tracking System
Source: EPA
Telephone: 202-564-4104
RCRA Administration Action Tracking System. RAATS contains records based on enforcement actions issued under RCRA pertaining to major violators and includes administrative and civil actions brought by the EPA. For administration actions after September 30, 1995, data entry in the RAATS database was discontinued. EPA will retain a copy of the database for historical records. It was necessary to terminate RAATS because a decrease in agency resources made it impossible to continue to update the information contained in the database.

Date of Government Version: 04/17/95 — Date of Last EDR Contact: 12/13/99
Database Release Frequency: No Update Planned — Date of Next Scheduled EDR Contact: 03/13/00

TRIS: Toxic Chemical Release Inventory System
Source: EPA
Telephone: 202-260-1531
Toxic Release Inventory System. TRIS identifies facilities which release toxic chemicals to the air, water and land in reportable quantities under SARA Title III Section 313.

Date of Government Version: 12/31/97
Database Release Frequency: Annually
Date of Last EDR Contact: 12/27/99
Date of Next Scheduled EDR Contact: 03/27/00

TSCA: Toxic Substances Control Act
Source: EPA
Telephone: 202-260-1444
Toxic Substances Control Act. TSCA identifies manufacturers and importers of chemical substances included on the TSCA Chemical Substance Inventory list. It includes data on the production volume of these substances by plant site.

Date of Government Version: 12/31/94
Database Release Frequency: Every 4 Years
Date of Last EDR Contact: 01/03/00
Date of Next Scheduled EDR Contact: 04/24/00

STATE OF TEXAS ASTM STANDARD RECORDS

SHWS: State Superfund Registry
Source: Texas Natural Resource Conservation Commission
Telephone: 512-239-5680
State Hazardous Waste Sites. State hazardous waste site records are the states' equivalent to CERCLIS. These sites may or may not already be listed on the federal CERCLIS list. Priority sites planned for cleanup using state funds (state equivalent of Superfund) are identified along with sites where cleanup will be paid for by potentially responsible parties. Available information varies by state.

Date of Government Version: 12/15/99
Date Made Active at EDR: 02/16/00
Database Release Frequency: Semi-Annually
Date of Data Arrival at EDR: 01/18/00
Elapsed ASTM days: 29
Date of Last EDR Contact: 01/18/00

LF: Permitted Solid Waste Facilities
Source: Texas Natural Resource Conservation Commission
Telephone: 512-239-6786
Solid Waste Facilities/Landfill Sites. SWF/LF type records typically contain an inventory of solid waste disposal facilities or landfills in a particular state. Depending on the state, these may be active or inactive facilities or open dumps that failed to meet RCRA Subtitle D Section 4004 criteria for solid waste landfills or disposal sites.

Date of Government Version: 12/01/99
Date Made Active at EDR: 01/04/00
Database Release Frequency: Quarterly
Date of Data Arrival at EDR: 12/20/99
Elapsed ASTM days: 15
Date of Last EDR Contact: 11/30/99

CLI: Closed Landfill Inventory
Source: Texas Natural Resource Conservation Commission
Telephone: 512-239-6016
Closed and abandoned landfills (permitted as well as unauthorized) across the state of Texas.

Date of Government Version: 10/01/97
Date Made Active at EDR: 12/09/98
Database Release Frequency: Annually
Date of Data Arrival at EDR: 10/09/98
Elapsed ASTM days: 61
Date of Last EDR Contact: 11/08/99

LUST: Leaking Petroleum Storage Tank Database
Source: Texas Natural Resource Conservation Commission
Telephone: 512-239-2200
Leaking Underground Storage Tank Incident Reports. LUST records contain an inventory of reported leaking underground storage tank incidents. Not all states maintain these records, and the information stored varies by state.

Date of Government Version: 10/01/99
Date Made Active at EDR: 11/19/99
Database Release Frequency: Quarterly
Date of Data Arrival at EDR: 11/08/99
Elapsed ASTM days: 11
Date of Last EDR Contact: 11/02/99

UST: Petroleum Storage Tank Database
Source: Texas Natural Resource Conservation Commission
Telephone: 512-239-2160
Registered Underground Storage Tanks. UST's are regulated under Subtitle I of the Resource Conservation and Recovery Act (RCRA) and must be registered with the state department responsible for administering the UST program. Available information varies by state program.

Date of Government Version: 10/01/99
Date Made Active at EDR: 11/23/99
Database Release Frequency: Quarterly
Date of Data Arrival at EDR: 11/08/99
Elapsed ASTM days: 15
Date of Last EDR Contact: 11/02/99

STATE OF TEXAS ASTM SUPPLEMENTAL RECORDS

AST: Petroleum Storage Tank Database
Source: Texas Natural Resource Conservation Commission
Telephone: 512-239-2160
Registered Aboveground Storage Tanks.

Date of Government Version: 10/01/99
Database Release Frequency: Quarterly
Date of Last EDR Contact: 11/02/99
Date of Next Scheduled EDR Contact: 01/31/00

SPILLS: Spills Database
Source: Texas Natural Resource Conservation Commission
Telephone: 512-239-0983

Date of Government Version: 01/02/00
Database Release Frequency: Quarterly
Date of Last EDR Contact: 12/27/99
Date of Next Scheduled EDR Contact: 03/27/00

VCP: Texas Natural Resource Conservation Commission
Source: Voluntary Cleanup Program Sites
Telephone: 512-239-0911
The Texas Voluntary Cleanup Program was established to provide administrative, technical, and legal incentives to encourage the cleanup of contaminated sites in Texas.

Date of Government Version: 11/03/99
Database Release Frequency: Quarterly
Date of Last EDR Contact: 11/12/99
Date of Next Scheduled EDR Contact: 02/07/00

MM: Multi Media Enforcement Cases
Source: Texas Natural Resource Conservation Commission
Telephone: 512-239-6012
Any enforcement case with more than one media (water, waste, etc.) violation.

Date of Government Version: 08/31/99
Database Release Frequency: Semi-Annually
Date of Last EDR Contact: 12/13/99
Date of Next Scheduled EDR Contact: 03/13/00

IHW: Industrial & Hazardous Waste Database
Source: Texas Natural Resource Conservation Commission
Telephone: 512-239-0985
Summary reports reported by waste handlers, generators and shippers in Texas.

Date of Government Version: 06/30/99
Database Release Frequency: Annually
Date of Last EDR Contact: 11/08/99
Date of Next Scheduled EDR Contact: 02/07/00

WASTEMGT: Commercial Hazardous & Solid Waste Management Facilities
Source: Texas Natural Resource Consevation Commission
Telephone: 512-239-2920
This list contains commercial recycling facilities and facilities permitted or authorized (interim status) by the Texas Natural Resource Conservation Commission.

Date of Government Version: 06/01/98
Database Release Frequency: Annually
Date of Last EDR Contact: 11/08/99
Date of Next Scheduled EDR Contact: 02/07/00

AIRS: Current Emission Inventory Data
Source: Texas Natural Resource Conservation Commission
Telephone: N/A
The database lists by company, along with their actual emissions, the TNRCC air accounts that emit EPA criteria pollutants.

Date of Government Version: 10/07/99
Database Release Frequency: N/A

Date of Last EDR Contact: 01/17/00
Date of Next Scheduled EDR Contact: 04/17/00

EDR PROPRIETARY DATABASES

Former Manufactured Gas (Coal Gas) Sites: The existence and location of Coal Gas sites is provided exclusively to EDR by Real Property Scan, Inc. ©Copyright 1993 Real Property Scan, Inc. For a technical description of the types of hazards which may be found at such sites, contact your EDR customer service representative.

Disclaimer Provided by Real Property Scan, Inc.

The information contained in this report has predominantly been obtained from publicly available sources produced by entities other than Real Property Scan. While reasonable steps have been taken to insure the accuracy of this report, Real Property Scan does not guarantee the accuracy of this report. Any liability on the part of Real Property Scan is strictly limited to a refund of the amount paid. No claim is made for the actual existence of toxins at any site. This report does not constitute a legal opinion.

HISTORICAL AND OTHER DATABASE(S)

Depending on the geographic area covered by this report, the data provided in these specialty databases may or may not be complete. For example, the existence of wetlands information data in a specific report does not mean that all wetlands in the area covered by the report are included. Moreover, the absence of any reported wetlands information does not necessarily mean that wetlands do not exist in the area covered by the report.

PWS: Public Water Systems
Source: EPA/Office of Drinking Water
Telephone: 202-260-2805
Public Water System data from the Federal Reporting Data System. A PWS is any water system which provides water to at least 25 people for at least 60 days annually. PWSs provide water from wells, rivers and other sources.

PWS ENF: Public Water Systems Violation and Enforcement Data
Source: EPA/Office of Drinking Water
Telephone: 202-260-2805
Violation and Enforcement data for Public Water Systems from the Safe Drinking Water Information System (SWDIS) after August 1995. Prior to August 1995, the data came from the Federal Reporting Data System (FRDS).

Area Radon Information: The National Radon Database has been developed by the U.S. Environmental Protection Agency (USEPA) and is a compilation of the EPA/State Residential Radon Survey and the National Residential Radon Survey. The study covers the years 1986 - 1992. Where necessary data has been supplemented by information collected at private sources such as universities and research institutions.

EPA Radon Zones: Sections 307 & 309 of IRAA directed EPA to list and identify areas of U.S. with the potential for elevated indoor radon levels.

Oil/Gas Pipelines/Electrical Transmission Lines: This data was obtained by EDR from the USGS in 1994. It is referred to by USGS as GeoData Digital Line Graphs from 1:100,000-Scale Maps. It was extracted from the transportation category including some oil, but primarily gas pipelines and electrical transmission lines.

Sensitive Receptors: There are individuals deemed sensitive receptors due to their fragile immune systems and special sensitivity to environmental discharges. These sensitive receptors typically include the elderly, the sick, and children. While the location of all sensitive receptors cannot be determined, EDR indicates those buildings and facilities - schools, daycares, hospitals, medical centers, and nursing homes - where individuals who are sensitive receptors are likely to be located.

USGS Water Wells: In November 1971 the United States Geological Survey (USGS) implemented a national water resource information tracking system. This database contains descriptive information on sites where the USGS collects or has collected data on surface water and/or groundwater. The groundwater data includes information on more than 900,000 wells, springs, and other sources of groundwater.

Flood Zone Data: This data, available in select counties across the country, was obtained by EDR in 1999 from the Federal Emergency Management Agency (FEMA). Data depicts 100-year and 500-year flood zones as defined by FEMA.

NWI: National Wetlands Inventory. This data, available in select counties across the country, was obtained by EDR in March 1997 from the U.S. Fish and Wildlife Service.

Epicenters: World earthquake epicenters, Richter 5 or greater
Source: Department of Commerce, National Oceanic and Atmospheric Administration

Water Dams: National Inventory of Dams
Source: Federal Emergency Management Agency
Telephone: 202-646-2801
National computer database of more than 74,000 dams maintained by the Federal Emergency Management Agency.

Texas Groundwater Database
Source: Texas Water Development Board
Telephone: 512-936-0837

Texas Oil and Gas Wells: Inventory of oil and gas wells in select Texas counties
Source: Texas Railroad Commission

Texas Public Water Supply Database on Ground and Surface Water
Source: Texas Natural Resource Conservation Commission

Texas Harris-Galveston Coastal Subsidence District Water Well Database
Source: Harris-Galveston Coastal Subsidence District

Texas Water Development Board Groundwater Database
Source: Texas Water Development Board
Telephone: 512-936-0833

AQUIFLOW™ Information System
Source: EDR proprietary database of groundwater flow information
EDR has developed the AQUIFLOW Information System (AIS) to provide data on the general direction of groundwater flow at specific points. EDR has reviewed reports submitted to regulatory authorities at select sites and has extracted the date of the report, hydrogeologically determined groundwater flow direction and depth to water table information.